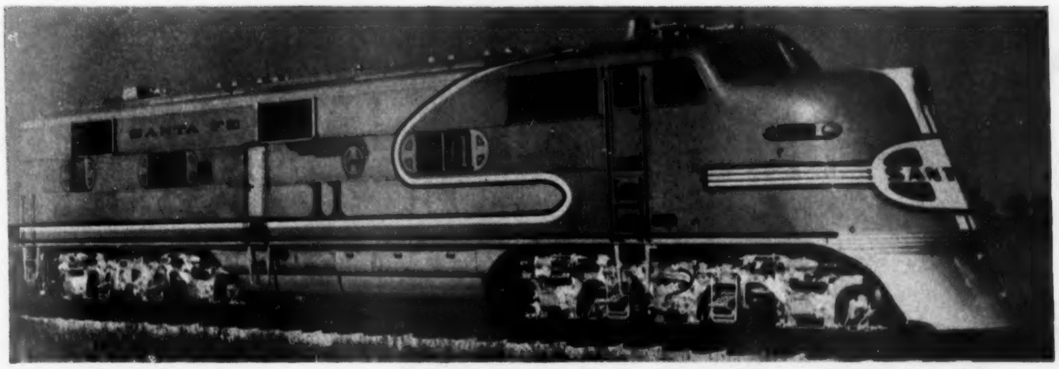

See page 131

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Design, Operation and Maintenance of

Diesel Locomotives*

By H. V. Gill †

Operating results and maintenance methods with 14 road locomotives and 41 switchers, aggregating 64,900 hp., outlined in this paper

DURING 1934, several lightweight articulated trains were built and placed in service on western railroads and proved highly successful in attracting the traveling public. They were powered with one Diesel engine located in the first car of the train and since these trains were articulated, cars could not conveniently be added to or taken from the trains. They were, therefore, not adaptable for interchange service, particularly where cars would be occupied by parties, and due to this construction could not be operated on other railroads.

The Atchison, Topeka & Santa Fe decided to purchase a Diesel-electric locomotive of sufficient horsepower to handle 14 heavyweight passenger cars on grades up to 1 per cent making the then present schedules for steam-powered passenger trains. Engineers of the Santa Fe and the Electro-Motive Corporation collaborated on this design and in November, 1935, the locomotive was delivered. It consisted of two units coupled together, having a total over-all length of 127 ft. 8 in. weighing 258 tons. The maximum speed was 98 m. p. h. using a 22:55 gear ratio. The power was supplied by four 900-hp. two-cycle Diesel engines. Also in February, 1935, a 600-hp. Diesel-electric switching locomotive was placed in service, powered with a 600-hp. four-cycle Diesel engine.

Since these two locomotives were installed, 40 additional Diesel-electric switching locomotives and 13 high-speed road passenger units have been purchased. At this date on the Santa Fe, there is a total of 64,900 Diesel hp. in service, 37,500 hp. in switching service and 27,400 hp. in high-speed passenger service.

The road passenger locomotive units are each powered with two 12-cylinder, two-cycle Diesel engines, the horsepower rating being 1,800 to 2,000-hp. per unit. The maximum speed is 117 m. p. h. using a 25:52 gear ratio. These units have accumulated 5,625,523 miles to November 1, 1939, with an availability of 95.3 per cent.

This increase in the use of Diesel-electric locomotives has occurred over a comparatively short period of time. It is, therefore, well to analyze the characteristics of the Diesel electric locomotive to point out some of the inherent advantages which explain why its use on the railroads has increased so greatly in the last five years.

Inherent Advantages of Diesel-Electric Drive

The uniform torque exerted by the electric motors at each driving axle, gives a smooth and effective application of power without undesirable shocks or jerks. The Diesel engine which constitutes the prime mover, delivers full rated horsepower at all train or locomotive speeds, the power generated reaching the driving axle through the electric transmission. The availability of Diesel-electric locomotives is high, as they do not require frequent extensive repairs, frequent watering or fueling, boiler washing or fire cleaning. In road service, repairs may be made currently, while in switching service, inspections and repairs may be made monthly. The availability of Diesel locomotives in road service on the Santa Fe, based on assigned miles, is 95.3 per cent, while for switching locomotives it is 90.6 per cent to November 1, 1939.

Due to the swivel truck and long wheel base, the elimination of reciprocating parts and low center of gravity, the Diesel locomotive is easy on the track and will operate at high sustained speeds on fast schedules. The thermal efficiency of the Diesel engine is about 27 per cent, which results in good fuel economy, resulting in fewer stops for fuel. Diesel locomotives are free from smoke, cinders and soot. Due to fewer stops required for fuel and water and infrequent stops for servicing, the Diesel-electric locomotive may be operated over much greater distances with lower top speeds to make a given schedule. Therefore, Diesel-powered trains may run on faster schedules than steam-powered trains.

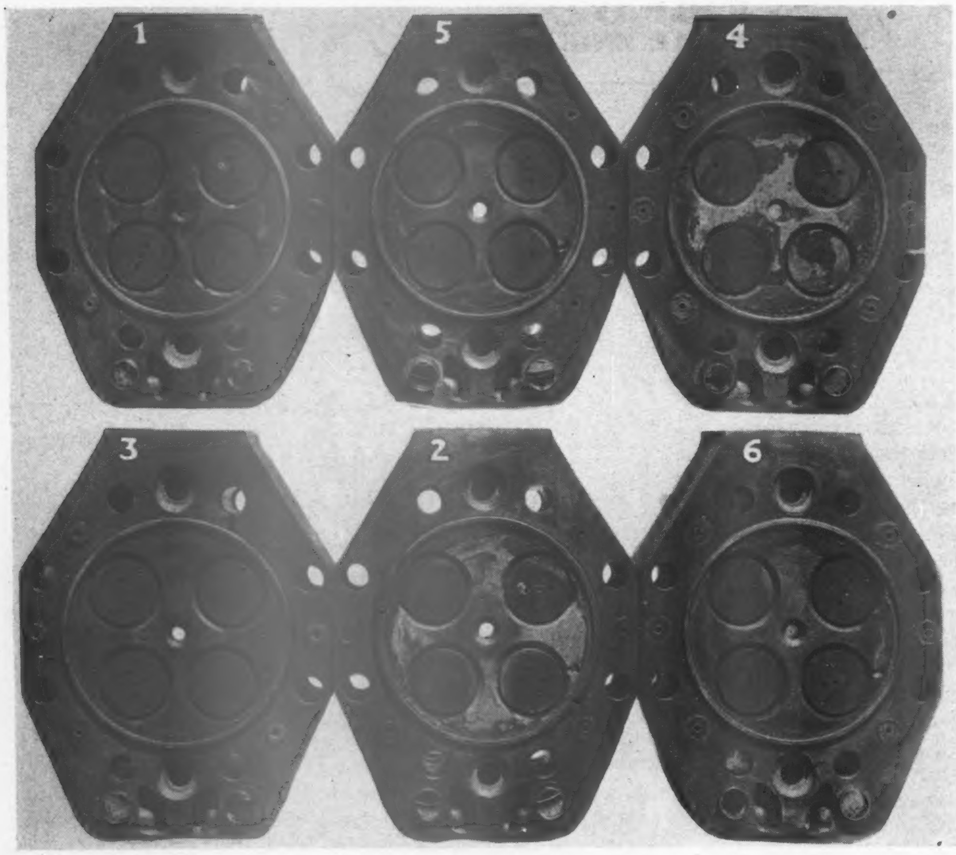
In a Diesel-electric switching locomotive, all of the weight is carried on the driving wheels, which gives an effective return for locomotive weight and since the average speed for switching operations rarely exceeds 6 or 7 m. p. h., by selecting the proper gear ratio between the traction motor and power axle (about 4:1), the Diesel-electric switcher will handle the work of a steam locomotive which has a horsepower rating of approximately two and one-half times that of the Diesel locomotive. It will operate anywhere a freight car may be handled, and after the crews become familiar with its operation, they find they can handle their work faster.

Both road and switching locomotives are easy to handle, operation by the engineman being accomplished with little physical exertion. This, combined with the features of good visibility, clean and comfortable cabs, makes them acceptable to the operating crews.

The above mentioned characteristics result in economical operation for both road and switching locomotives as indicated in cost of operation data shown in Tables I and II. These operating cost data do not include depreciation or wages of enginemen. To date it has not been necessary to give any of the Diesel locomotives general repairs.

* Abstract of a paper presented at the Truck, Bus and Rail Car meeting of the Society of Automotive Engineers, held at Los Angeles, Calif., February 9, 1940.

† Supervisor of Diesel locomotives, Atchison, Topeka & Santa Fe, Chicago.



A set of cylinder heads from a Diesel engine that had been in service for two years. The extent of the carbon accumulation may be clearly seen in the area just outside the valves—In the case of No. 1 head the accumulation was about .020 in. thick at the outer edges of the area and a minimum accumulation is seen in the case of No. 5 head. No. 2 head shows a typical condition of the water passages

Electric Transmission a Limiting Factor

The electric transmission, an important and expensive part of the Diesel equipment, at the present time is one of the limiting factors insofar as continuous operation on heavy grades is concerned. This is due to the necessity of dissipating the thermal losses from the traction motors and generators. For instance, a 4,000-hp. Diesel-electric locomotive that has a starting tractive force of 103,300 lb., and 43,000 lb. tractive force at 30 m. p. h. is limited to 26,400 lb. tractive force continuously at 40 m. p. h. Greater tractive force than the above may be developed for short periods provided the temperature limits of the electric transmission are not exceeded. A locomotive of 4,000-hp. has handled 765 tons (8 lightweight and 4 heavyweight cars) up 1.8 per cent grades on fast schedules between Chicago and Los Angeles.

In selecting or assigning Diesel-electric locomotives for service, the thermal capacity of the electric transmission must be carefully considered to make sure that it is sufficient for the duty cycle. Traction motors within the last five years have increased in capacity from 240 hp. to 500 hp. per motor, and we expect further increases in the thermal capacity and mechanical strengthening of traction motors to meet more severe duty cycles.

Since steam is required for heating and air-conditioning passenger trains, some means of supplying this demand is necessary on Diesel-electric locomotives in road service. This condition was met by the development of a steam generator. Occupying a comparatively small space, one of these generators is capable of supplying 2,250 lb. of steam per hour at 200-lb. pressure.

Liberal use is made of alloys in the design and construction of Diesel locomotives to secure maximum strength with minimum weight. Crankshafts are high carbon steel forgings, some of the bearing surfaces of which are hardened by the Tocco process. Connecting rods are alloy-steel forgings. Pistons are drop-forged aluminum or cast malleable iron. Piston pins are of high-carbon steel. Cylinder liners and cylinder heads are of cast iron. The valves are of special heat-resistant steel. Diesel engine frames and cylinder blocks are of carbon-molybdenum steel. Locomotive frames and all parts of the body that form structural supports are of carbon-molybdenum steel. Cover sheets are of stainless or USS Cor-Ten steel. Electric welding is used extensively to fabricate parts of Diesel locomotives.

Table I—Operating Cost of 3,600 Hp. Diesel-Electric Locomotives in High-Speed Passenger Service—Year 1938

	Cost per locomotive-mile
Fuel	$.0469
Locomotive repairs, labor and material	.1063
Lubrication	.0151
Supplies	.0028
Water	.....
Total cost per mile	$.1711

Table II—Cost of Operation Per Service Hour in Switching Service*

	600-hp. 2-cycle Diesel-electric	600-hp. 4-cycle Diesel-electric	1,000-hp. 2-cycle Diesel-electric†	1,000-hp. 4-cycle Diesel-electric†	Steam locomotives Santa Fe 566 class
Fuel	$.199	$.290	$.247	$.275	$1.53
Locomotive repairs, labor and material	.286	.143	.129	.119	1.12
Estimated cost of general repairs	.25	.25	.25	.25	...
Enginehouse expense	.060	.046	.030	.026	1.38
Lubrication	.073	.033	.062	.019	.06
Supplies	.009	.013	.006	.008	.04
Water	...	...	...	...	.30
Total per service hour	$.877	$.775	$.724	$.697	$4.43

* These cost figures, not including depreciation, or wages of enginemen, indicate an average saving of $3.66 per service hour over steam operation in switching service.

† In service only three months.

S.D. 8-39 2M 7255

Form 1226-DS-Standard

Santa Fe

Monthly Record of Maintenance and Inspection--Diesel Switch Locomotives

Date ....

Station ....

Locomotive No.————

DIESEL ENGINE—INSPECT AND REPAIR

ITEM	WORKMAN	ITEM	WORKMAN	ITEM	WORKMAN
1. Inspect crank cases		8. Check fuel system piping		15. Check injectors for tightness	
2. Check injection timing		9. Check safety cutoff valve in fuel system		16. Check water pump	
3. Check injector control linkage setting		10. Check fuel pumps		17. Check main governor	
4. Check cylinder head valve lash adjusters or valve clearance		11. Inspect pistons		18. Check overspeed governor	
5. Check cylinder heads for leaky valves		12. Check lubricating oil system		19. Inspect cooling radiators and connecting piping	
6. Inspect all vee-belt drives		13. Drain sediment from fuel tanks		20. Blow out all radiators	
7. Flush engine cooling system		14. Inspect timing chain or timing gears		21. Inspect coupling between Diesel engine and generator	

ELECTRICAL EQUIPMENT—INSPECT, TEST, REPAIR, AND CLEAN

ITEM	WORKMAN	ITEM	WORKMAN	ITEM	WORKMAN
22. Main generator		30. Check for and clear grounds		38. Traction motors	
23. Exciter generator		31. Fuel pump motors		39. Traction motor cables	
24. Auxiliary generators		32. Radiator fan motors		40. Traction motor drive gears	
25. High-voltage cabinet		33. Compressor motors		41. Engineers control station	
26. Low-voltage cabinet		34. Steam generator motors		42. Batteries	
27. Control circuits		35. Cab heater motors		43. Steam generator controls	
28. Main contactors and reverser		36. Blower fan motors		44. All wiring connections	
29. Compressor governor		37. Head and cab lights		45. Relays	
				46. Voltage Regulators	

LUBRICATION

ITEM	WORKMAN	ITEM	WORKMAN	ITEM	WORKMAN
47. Fuel pump motor		56. Drain oil in Diesel engine as instructed. Date of last oil change..................		63. Truck pedestal jaws	
48. Radiator fan motors				64. Throttle control linkage	
49. Compressor motors		57. Change oil in air compressor every 3 months		65. Drain and refill steam generator feed-water pump	
50. Steam generator motors				66. Repack waste-type traction motor armature bearings	
51. Cab heater motors		58. Main contactor and reverser air cylinders		67. Examine and repack traction motor suspension bearings as instructed	
52. Blower fan motors		59. Check oil in main governor			
53. Main generator		60. Truck journal boxes		68. Traction motor gears	
54. Auxiliary generator		61. Truck center castings		69. Roller-bearing traction motor armatures	
55. Exciter generator		62. Brake rigging			

CLEANING / SPECIAL ITEMS

CLEANING				SPECIAL ITEMS	
70. Diesel engine crankcases		76. Diesel engine cylinder heads		81. Inspect and test all fire extinguishers	
71. All lubricating oil strainers		77. Fuel tank filling strainers		82. Main Crankshaft Bearings Remove and examine every annual inspection of locomotive.	
72. All fuel strainers		78. Engine room			
73. All fuel filters		79. Exterior of locomotive			
74. All lubricating oil filters		80. Engineers cab			
75. All air intake filters					

ADDITIONAL INSPECTIONS

1. Air brake equipment shall be inspected and maintained as per locomotive folio and recorded on form 1154 Santa Fe standard.
2. Steam generator shall be inspected and tested as per I. C. C. requirements and report recorded on form 2532 B Santa Fe standard.
3. Running gear, draft gear and couplers, fuel system, and safety appliances shall be maintained as per I. C. C. requirements and report recorded on form 2532-A Santa Fe standard.
4. Remove and recondition all cylinder heads as per instructions.
5. Remove and recondition all piston and connecting rod assemblies as per instructions.
6. Check oil level in waste-packed traction motor bearings at least once per week.

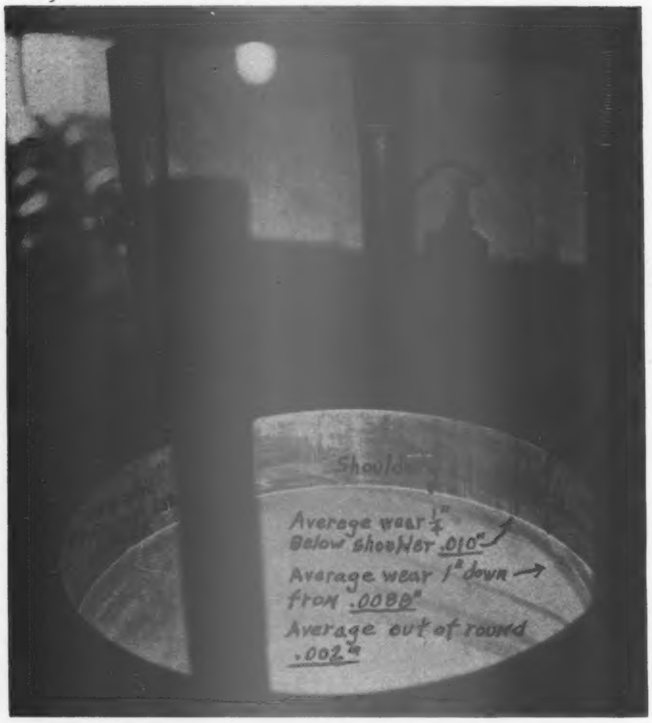
REPAIRS MADE OTHER THAN LISTED ABOVE, AND MATERIALS USED

Show serial numbers of parts removed and parts applied.

Approved by:

Foreman

Form used by the A. T. & S. F. for the monthly maintenance and inspection of Diesel-electric switching locomotives



Condition of cylinder liner after two years' service—The wear at different points is indicated

How the Equipment Is Maintained

In maintaining and operating Diesel locomotives, one of the major problems confronting all railroads is to train the personnel to handle and maintain this type of power. New facilities, tools, etc., are required.

At Chicago, the Santa Fe has built a shop especially designed for handling Diesel locomotive repairs. The shop is of the longitudinal type, 282 ft. long by 111 ft. wide. It is equipped with cranes, hoists, drop tables and machine tools. With these new facilities repairs should be expedited, resulting in greater availability for service and a reduction in maintenance costs.

Special maintenance and inspection schedules in addition to the I. C. C. requirements, have been found necessary to secure reliable economical service from the locomotives. These requirements are met by the Santa Fe standard monthly schedule Form 1226-DS for Diesel-electric switching locomotives. For road service, the Santa Fe standard schedule Form 1226-D is used. Maintenance and inspections for road service are handled on a mileage basis. A copy of Form 1226-D is carried on each respective locomotive unit: therefore, the record of maintenance and inspection is always available to maintenance forces over the system. A special instruction bulletin has been issued to cover in detail just what attention each item on forms 1226-D and 1226-DS requires.

In road service a Diesel maintainer always rides the locomotive while it is in service. These maintainers are organized on a system basis. They make a complete log

Form 1226-D Standard

Santa Fe

DIESEL ROAD LOCOMOTIVES, RECORD OF INSPECTION AND MAINTENANCE, A. T. & S. F. RY.

Locomotive Number ________ Month of ________ Trains ________ Station ________

HANDLE EVERY 2500 MILES - ITEMS 1 TO 13 INCLUSIVE

1 Check oil level and condition of oil in all Diesel engines	2 Lubricate-Truck center plates, brake rigging, spring rigging and truck pedestal jaws.	3 Lubricate traction motor axle suspension bearings.	4 Lubricate Diesel engine water pump shafts.	5 Inspect all fire extinguishers. See that they are in good operating condition and filled.	6 Check oil level and condition of oil in truck journal boxes.	7 Lubricate traction motor drive gears.	8 Drain water and sediment from fuel and steam generator water tanks.	9 Check oil level and condition of oil in all air compressors, & steam generator water pumps.	10 Clean Diesel engine and air compressor, air intake filters	11 Clean all lubricating oil filters.	12 Test steam generator.	13 Inspect and thoroughly clean all traction motors
1.												
2.												
3.												
4.												
5.												
6.												
7.												
8.												

HANDLE EVERY 4500 MILES - ITEMS 14 TO 26 INCLUSIVE

14 Inspect traction motor gears for worn condition.	15 Inspect Diesel engine crank case, inside and outside.	16 Inspect Diesel engine pistons and piston rings through air box.	17 Inspect all "Vee" belt drives.	18 Inspect and clean main generators.	19 Inspect and clean auxiliary and exciter generators.	20 Inspect and clean high and low voltage cabinets	21 Check for grounds and clear up all exsisting grounds.	22 Lubricate traction motor pinion and armature bearings. Apply 8 ounces grease.	23 Inspect fuel and water tank filler opening strainers. Clean if required.	24 Flush engine cooling system and check for leaks or defective conditions	25 Inspect fire pot and clean ignition system on steam generators.	26 Inspect and clean boiler control system
1.												
2.												
3.												
4.												
5.												

HANDLE EVERY 9000 TO 10,000 MILES - ITEMS 27 TO 39 INCLUSIVE

27 Clean and inspect all fuel pump motors.	28 Inspect and clean steam generator motors and blowers.	29 Inspect carefully traction motor cables.	30 Apply 2 to 4 ounces of grease to main generator bearings.	31 Apply 1 to 2 ounces of grease to auxiliary and exciter generator bearings.	32 Apply 1/2 ounce grease to all bearings of fuel pump motors, boiler motors, and boiler blower.	33 Apply 2 ounces of grease to traction motor blower bearings.	34 Apply 4 ounces of grease to main engine cooling fan bearings	35 Grease lightly, governor, throttle, and injector control linkage.	36 Test fuel system for leaks, and test emergency fuel shut-off valves.	37 Clean all fuel oil filters and strainers inside engine room.	38 Check injectors for looseness and for leaky condition or stuck plungers.	39. Inspect all wiring connections and wiring for looseness or worn insulation.
1.												
2.												
3.												

HANDLE EVERY 20,000 MILES - ITEMS 40 TO 52 INCLUSIVE

40 Examine all traction motor axle suspension bearings.	41 Inspect steam generator for soot accumulation on coils. Clean if required.	42 Wash out steam generator water supply tanks and suction pipes	43 Clean out the interior of all Diesel engines	44 Clean all lubricating oil strainers.	45 Test out all control circuits for proper operation.	46 Examine and lubricate speedometer generator.	47 Lubricate air cylinders of all power switches.	48 Lubricate reverser air cylinders.	49 Check exhaust valve lash adjuster settings Diesel engines.	50 Check injector timing, all Diesel engines.	51 Check injector control linkage for proper adjustment.	52 Lubricate traction motor commutator end bearings. Apply 6 ounces of grease.
1.												
2.												

HANDLE EVERY 30,000 MILES				HANDLE EVERY 60,000 MILES		SPECIAL ITEMS-Fill in Headings			REMARKS:
53 Drain crank case lubricating oil from Diesel engines.		54 Clean off top of all cylinder heads, and clean out cam pockets.	55 Inspect timing chain and show engine number.	56 Drain air compressor crank case lubricating oil.	57 Drain crank case lubricating oil — steam generator water pumps.	58	59	60	
No. 1 Engine	No. 2 Engine								
1.									
2.									
3.									
4.									
5.									

Table III—Principal Characteristics of Diesel-Electric Locomotives now in Service on the Atchison, Topeka & Santa Fe

No. of locomotives	Manufacturer	Horsepower and class of service	Number of Diesel engines per locomotive	Weight of locomotive, lb.	Maximum speed m.p.h.	Starting tractive, lb.	Electrical Equipment
4	EMC	600 hp. switch	1	205,780	40	51,445	G E
1	BLW	660 hp. switch	1	213,840	45	53,460	A C
3	ALCO	600 hp. switch	1	196,240	40	49,060	1-GE 2-West
3	EMC	900 hp. switch	2	257,340	40	64,335	West
12	ALCO	1,000 hp. switch	1	227,900	60	57,000	G E
5	BLW	1,000 hp. switch	1	244,970	60	62,000	West
13	EMC	1,000 hp. switch	1	249,200	60	62,325	EMC
12 units	EMC	Road pass. 1,800 hp.	2	290,500	117	50,750	G E
2 units	EMC	road pass. 2,000 hp.	2	306,900	117	51,640	EMC

EMC—Electro-Motive Corporation
BLW—Baldwin Locomotive Works
ALCO—American Locomotive Company
GE—General Electric Co.
AC—Allis Chalmers Mfg. Co.
West—Westinghouse El. & Mfg. Co.

report of each trip, report to maintenance terminals all repairs and inspections required, and inspect the locomotives sufficiently in advance of departure from a terminal to insure that necessary repairs have been properly made.

Approximately 63 per cent of the repair charges to Diesel locomotives are for materials. Since these materials are expensive and changes in design are frequently made, it has become necessary to set up a special system to govern the supply of new repair parts on hand and the handling of worn or defective materials over the system. All requisitions for new materials and disposition of worn or defective parts are handled through a central point on the Santa Fe. All requisitions must be approved and periodical inventories of store department supplies are made.

A specially trained man has been assigned to follow this disposition of materials and he also keeps mileage records of locomotive performance and records of service received from cylinder heads, cylinder liners, pistons, traction motors, axles, wheels and other parts that are subject to frequent inspections or renewals.

Advantage is taken of the ability of Diesel locomotives to run for long periods without taking on fuel or water.

Table IV—Diesel Lubricating Oil Specifications

	Switching service	Road service
Gravity, Baumé	19.1	17.6
Flash, deg. F.	395	435
Fire, deg. F.	450	500
Viscosity at 210 deg. F.	62	85
Pour, deg. F.	−10	10
Ash, per cent	.003	.003
Neutralization no. per cent	.02	.02
Carbon residue, per cent	.07	.25

Switching locomotives are fueled two or three times a week while road locomotives run over 600 miles between

ADDITIONAL INSPECTIONS

1. Brake rigging, draft gear, engine room, engineer's cab, running gear and power plant shall be inspected as required and proper report made on form 2532A Santa Fe Standard.
2. Steam generators shall be inspected as required and proper report made on form 2532 B Santa Fe Standard.
3. Air brake system and signal equipment shall be inspected and tested as per standard instructions and proper report made on form 1154 Santa Fe Standard.
4. Train control, when used, shall be inspected as per standard instructions and proper report made on cab form and on form 1225 B Santa Fe Standard.
5. Main Crankshaft bearings all Diesel Engines to be inspected every 100,000 miles. 6-Locomotive must be checked for grounds in electrical equipment each trip.

TRIP MILEAGE RECORD

Locomotive Unit	Date	Train No.	Run From	To	Trip Mileage	Accumulated Mileage

ENGINE INSPECTION RECORD

Accumulated Mileage at time of Inspection	Date	Station	Pistons Removed	Injector Changed	Cylinder Heads	Cylinder Liners	Connecting rod Bearings	State number each item replaced and defect
			ENGINE NO. 1					
			ENGINE NO. 2					

TRACTION MOTORS REMOVED

Date	Remarks

WHEEL ASSEMBLYS REMOVED

Date	Remarks

Reverse side of Form 1226-D, the front of which is shown on the opposite page

fuel and water stations. For locomotives operating between Chicago and Los Angeles, a distance of 2,227.2 miles, fuel and water are taken at Newton, Kan.; Albuquerque, N. M., and at Needles, Calif. Switching locomotives are fueled during the operating crew's lunch period.

In switching service, locomotives are assigned to three shifts, 24 hours a day service, in order to take full advantage of the savings possible with this type of power. Switching locomotives give little trouble due to a low load factor—about 15 per cent.

A specially trained Diesel man is assigned to follow switching locomotives over the system. He inspects the locomotives, checks the operation and instructs maintenance forces and operating crews in proper Santa Fe practices.

Table V—Diesel Fuel Oil Specifications

Gravity, A.P.I.	28
Viscosity (S.S.U.) at 100 deg. F.	38
Flash	150 deg. F. minimum
Conradson carbon residue (maximum)	0.05 per cent
Acidity and alkalinity	Desired neutral
90 per cent distillation end point	Hold to Navy specifications
Water and sediment (maximum)	0.1 per cent
Ash (maximum)	0.02 per cent
Sulphur (maximum)	0.5 per cent
Centane number (minimum)	0.50

In switching service the four-cycle Diesel engine has given a good account of itself. This type of Diesel engine is being operated continuously for two years between removal of cylinder heads, piston assemblies, etc., for general inspection and repairs. An indication of the condition of these engines, after two years continuous service, is shown in the illustrations. All piston rings were free, wear of parts reasonable, carbon accumulation light and fluffy.

All of the present road locomotives are powered with two-cycle Diesel engines. Since these locomotives are operated under a load factor of about 60 per cent, more trouble is experienced with the Diesel engines. In fact, the Diesel engine maintenance expense comprises about 56 per cent of the total locomotive repair costs.

The use of good air filters and oil filters has increased lubricating oil drain periods from 5,000 miles to 100,000 miles of service for road locomotives. In switching service, crankcase lubricating oil is changed every three to six months of service. The specifications for lubricating oils and fuels used are given in Tables IV and V.

One of the illustrations shows a piston assembly from a two-cycle Diesel engine used in high speed passenger service after 100,000 miles of service. This piston assembly was found to be in good condition for further service.

This photograph shows the condition of the pistons and rings — The rings were free and the grooves clean. The oil holes in the pistons and the oil grooves in the rings are open — No wear was indicated on the pistons or piston pin assemblies

Cylinder liners that were worn .050 to .060 in. in about 60,000 miles are now removed when worn .020 in. after 325,000 miles of service and are reconditioned for reapplication. Cylinder heads are reconditioned every 100,000 miles and heads are repaired or reconditioned by welding.

Piston design has been improved. At the present time, the drop-forged aluminum piston with greatly increased ring land width is giving the most dependable service. Piston assemblies are removed for inspection every 100,000 miles and the service mileage received from pistons removed from road locomotives to date is 220,000 miles. This mileage will be greatly increased as new-type pistons replace the older design.

(Continued on page 149)

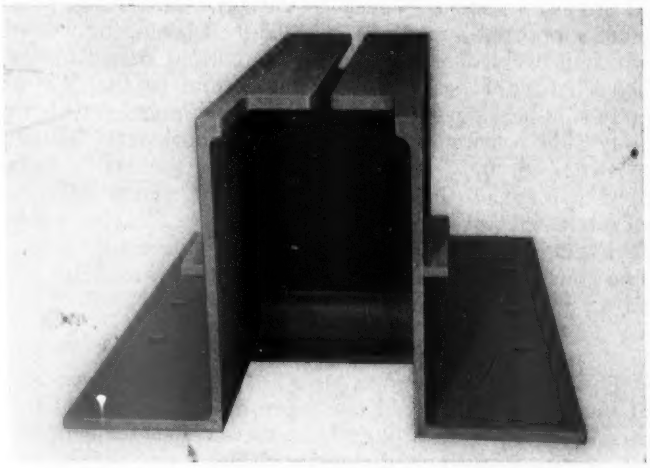
Table VI—Diesel Engines Now in Service on the Atchison, Topeka & Santa Fe

Manufacturer and type Diesel	Horsepower	Cycle	Number of cylinders	Arrangement	Bore and stroke, in	R.p.m.	Piston speed, ft. per min.	Weight of engine, lb. per hp.	Scavenging system	Injection system	Compression pressure, lb. per sq. in.	Combustion pressure, lb. per sq. in.	Mean effec. pressure, lb. per sq. in.	Number of engines in service
EMC 201-A	600	2	6	Line	8×10	750	1,250	21.9	Roots blower	Unit injectors	650	850	79.0	4
EMC 201-A	900	2	12	Vee	8×10	750	1,250	20.0	Roots blower	Unit injectors	650	850	79.0	29
EMC 567	1,000	2	12	Vee	8½×10	800	1,333	23.5	Roots blower	Unit injectors	600	1,250	73.0	17
Alco	600	4	6	Line	12½×13	700	1,518	58.4	None	Indiv. pumps	529	750	78.0	3
Alco	1,000	4	6	Line	12½×13	740	1,600	42.2	Buchi super charger	Indiv. pumps	480	750	110.0	12
De La Vergne Model VO	660	4	6	Line	12½×15½	600	1,550	31.2	None	Indiv. pumps	450	650	76.3	1
De La Vergne Model VO	1,000	4	8	Line	12¾×15½	625	1,604	34.0	None	Indiv. pumps	450	650	80.2	5

Northern Pacific Hoppers

Special attention to the design of the car as a whole with respect to weight reduction results in 75.8 per cent ratio of lightweight to total loaded weight

THE American Car and Foundry Company has recently completed and delivered to the Northern Pacific an order of 200 fifty-ton hopper cars having a load limit of 128,000 lb. and a light weight of 41,000 lb. The cars follow the conventional riveted hopper car design with the exception of the body bolster and welded bolster center filler and embrace the use of open-hearth carbon steel. While the car has a stenciled capacity of 100,000 lb., a load of 128,000 lb. can be handled without exceeding the capacity of the four 5½-in. by 10-in. axles. The revenue load is 75.8 per cent of the maximum load on rails and the ratio of pay load to tare weight is 3.12 to 1. The cars were built at the builder's Huntington, W. Va. plant.

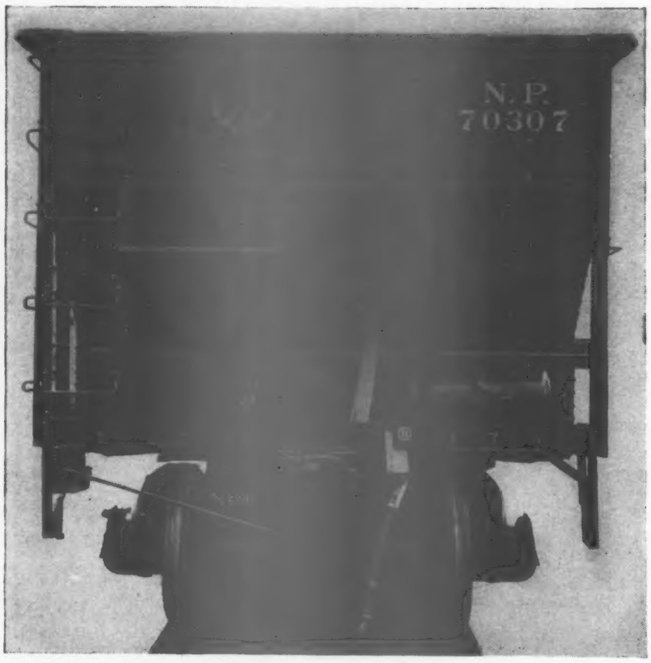


The bolster filler, consisting primarily of two A.A.R. Z sections, embodies the center pin guide and is secured to the center sills in an inverted position

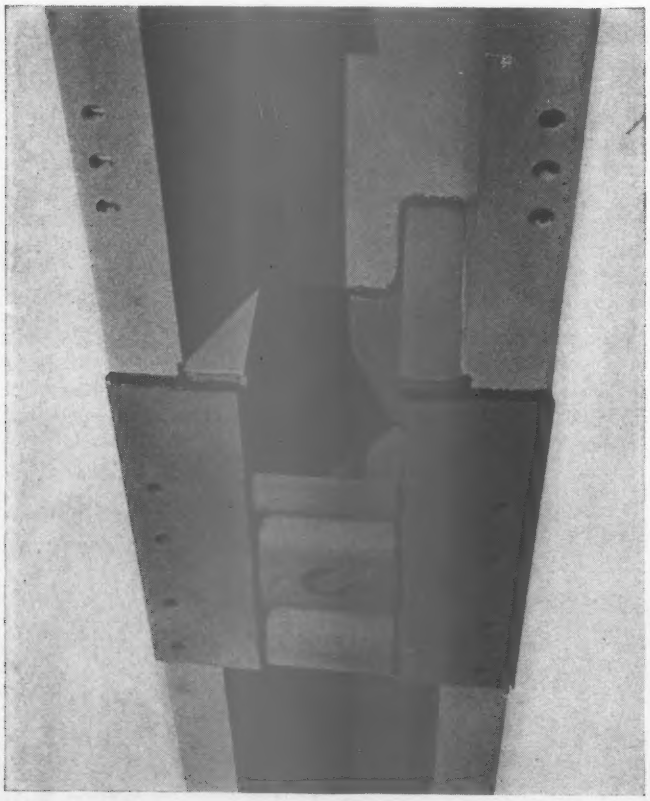
Underframe Construction

The center sills of this car consist of two A. A. R. Z-sections weighing 41.2 lb. per ft., welded together along the top center line. The special feature of the underframe is a fabricated construction at the bolster location. The use of steel castings for the bolster center filler has been replaced by the arrangement shown in the illustrations. The main members of the bolster center filler are two A. A. R. 36.2 lb. Z-sections, 24⅞ in. long placed in a reversed position, that is, with the heavy flanges at the top. These are welded along the flanged edges to the underside of the top flanges of the center-sill sections. The thin lower flanges pass under the heavy lower flanges of the center-sill sections to which they are secured by welding as well as by the rivets through the center plate and the lower flanges of the center sills. The rear draft-gear stop is a bar of USS Cor-Ten steel 1¼ in. by 3 in. by 12⅝ in. welded to the webs of the car center sills and to the web of the Z-shaped main member of the bolster center filler. A stiffener for the rear stop is welded to the vertical web of the draftgear main member and to the stop at the approximate neutral axis of the

Northern Pacific 50-ton hopper car built by American Car and Foundry Company



The end of the car—The I-beam bolster above the sills is seen under the slope sheet



A section of the center sill at the bolster showing the bolster filler construction

section. The bolster center filler design has been protected by patent application.

The center-pin guide is formed of two ⅜-in. steel plates shaped at their inner ends to form a pocket for the center pin and welded at their outer ends, full depth, to the vertical web of the main member of the bolster center filler. Over the center plate, between the webs of the main members of the center filler, there is a ⅜-in. ribbed plate welded to the main members for stiffness. Pressed diagonal braces of 5/16-in. material are used between the bolster and the end corners of the car. The body bolster, between the top of the center sill and the bottom of the slope sheet consists of a 21-in. by 8¼-in. by 59-lb. I beam with the upper flange bent to fit against the 30-deg. slope of the slope sheet. The upper flange is riveted to the floor sheets and the lower flange is welded to the top of the center sill. The outer end of the body bolster is riveted to the side structure through 3½-in. by 3-in. by ⅜-in. angles. A 6-in. by 4-in. by ⅜-in. angle is riveted to the web of each center-sill section and to the lower flange of the bolster I beam. The inner ends of the diagonal brace are also riveted to this angle. The body bolster is further reinforced toward the center of the car by a ¼-in. flanged plate, welded to the vertical web of the body bolster and to the top of the center-sill sections. The top flanges of this plate are riveted to the slope sheets.

The body side bearing is made up of 7/16-in. plate, No. 11 gage shim and a ⅜-in. high carbon, heat treated wear plate supported by an 8-in. by 20.5-lb. I beam, the web of which is welded at the top to the bottom flange of the body bolster I beam and at the bottom to the 7/16-in. body side-bearing plate. The three plate members of the body side bearing are riveted to the horizontal flanges of two 3-in. by 3-in. by ¼-in. angles, the inside ends of which rest on the bottom flange of the center sill construction and are welded thereto. These angles serve as diagonals to stiffen the body side bearing construction. The construction of the bolster and underframe end are shown in the drawings.

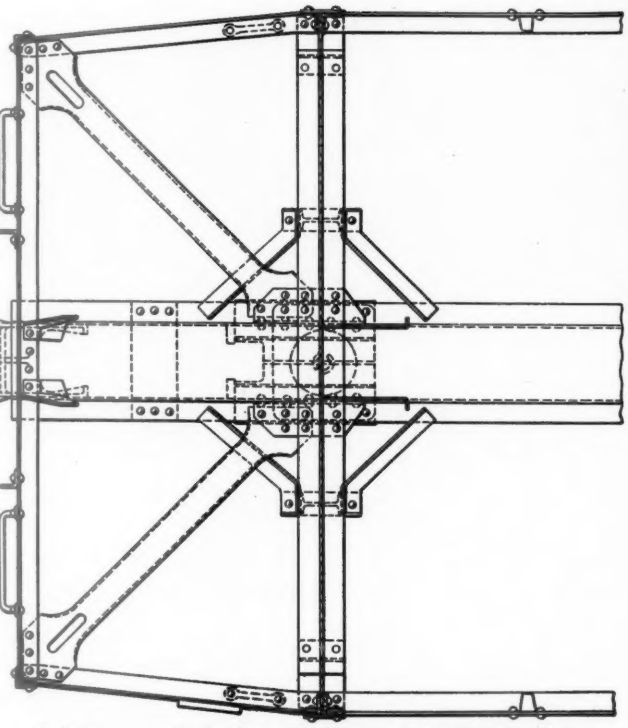
Body Construction

The side sills and end sills are 5-in. by 3½-in. by ⅜-in. angles running in one piece the full length of the car. The top, side, and end members consist of 5-in. by 3½-in. by 13.2-lb. bulb angles. The cross ridges are of ¼-in. plate with 3 3/16-in. 8.5-lb. Z-shaped bottom stiffeners and 3½-in. by 3½-in. by 5/16-in. side connection angles. The cross ridge and side-sheet braces are ¼-in. plate with 2½-in. by 3-in. by 6.1-lb. T-shaped stiffeners. The floor, or slope sheets, hoppers, car ends, and end side sheets are ¼-in. plate and the intermediate side sheets are 5/16-in. The floor sheets are flanged upward and riveted to the side sheets and are braced between the body bolster and end sill by 3½-in. by 3½-in. by 5/16-in. end angles. The side stakes are of the inside type pressed to U shape from 5/16-in. material. The car sides are sloped in at the top with outer side-stake fillers flush with the car sides. The hopper doors are flanged and pressed from 5/16-in. plate, are fitted to Enterprise hopper-door frames and equipped with Wine hopper-door fixtures.

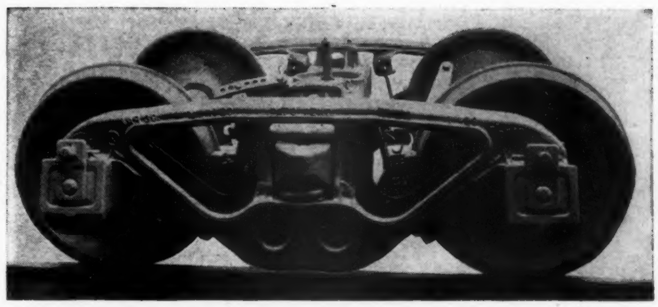
The trucks used on these cars are the National Type B

Principal Dimensions and Weights of Northern Pacific Hopper Cars

Length over strikers, ft.-in.	33-11¾
Length inside, ft.-in.	33- 0
Width inside, ft.-in.	10- 4
Width over-all, ft.-in.	10- 5
Height rail to top of side plate, ft.-in.	10- 5
Center to center of trucks, ft.-in.	24- 0
Truck wheel base, ft.-in.	5- 6
Capacity, lb.	100,000
Capacity, cu. ft.	2,081
Lightweight, lb.	41,000
Load limit, lb.	128,000
Ratio revenue to gross load, per cent	75.8
Ratio revenue to load to tare weight, per cent	3.12 to 1



Underframe end showing arrangement at bolster location

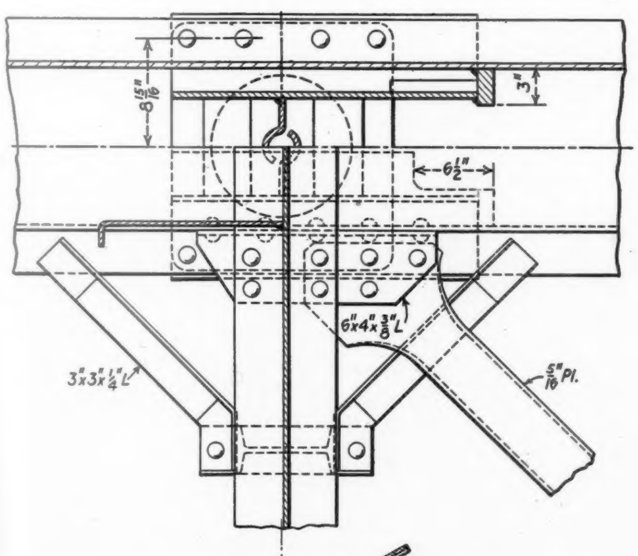


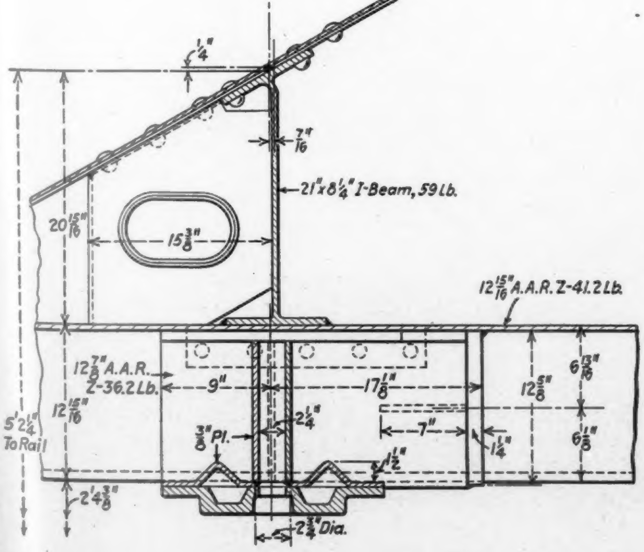
The four-wheel trucks have cast-steel side frames with boxes cast integral and wheels with treads ground after mounting on the axles

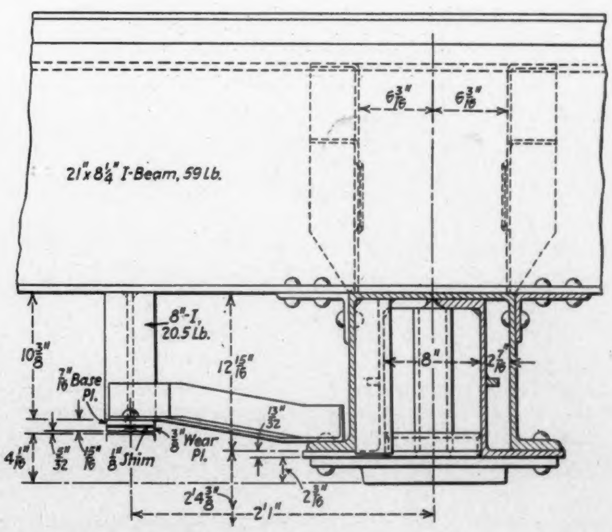
with the American Car and Foundry Company's chilled-iron single-plate wheels having treads ground after mounting on the axles. The trucks are constructed with cast-steel side frames having boxes cast integral, with cast-steel truck bolsters, Ajax brake beams, Schaefer brake-beam hangers, and Type E truck springs.

Draft Gear and Brakes

The cars are equipped with AB air-brake equipment furnished by Westinghouse and with Ajax hand brakes. The draft gear is the Edgewater friction type gear, with Buckeye Type E bottom-unlocking couplers, with cast-steel coupler yokes.







The arrangement of the welded fabricated steel center-sill filler, the 21-in. I-beam used between the top of the sills and the under side of the slope sheet, and the bracing are shown in these drawings

Equalizing the Flow of Air through

The Locomotive Grates

By S. H. Acker*

This paper presents the results of tests relating to the use of air restriction through the grates as means of controlling the draft and air distribution in a locomotive firebox

THE importance of the grates as a drafting device has been increasingly recognized, but even now there is a tendency to concentrate draft studies on the front end where the draft is created, rather than on the firebox where it is distributed, modified and used. A study of the results of tests conducted by the Northern Pacific on grates with restricted air openings and by the St. Louis-San Francisco on grates with non-uniform air openings will illustrate the importance of considering the grates when drafting locomotives. The grates developed by these tests have been standard equipment on the Northern Pacific for 14 years and on the St. Louis-San Francisco for 10 years. They have not only been proved by road test but they have withstood the trials of time.

Northern Pacific Tests

The Rosebud lignite coal fields in Montana cover large areas and the coal may be mined easily by the strip method. The mechanical department of the Northern Pacific obtained discouraging results from their first attempts to burn Rosebud lignite coal because it was so light that even with reduced tonnage in the train the fire would be pulled from the grates before the train could be moved to the main-line switch. Every conceivable adjustment was made to the standard drafting devices but still the fire could not be maintained. Finally, the air openings, through the grates, were restricted and a great improvement resulted immediately.

The successful burning of lignite coal by the Northern Pacific indicated that the use of grates as a drafting device, rather than as something necessary merely to sustain the coal while it is burned, would remove some of the restrictions on the quality of fuel required for locomotives. The Northern Pacific conducted a series of dynamometer-car tests to ascertain what results might be obtained by using the grates with restricted air openings, not only with lignite coal, but also with the bituminous coals which were then being burned on the locomotives of that road. The proximate analyses of the coal used in these tests is shown in Table I.

The results of the tests are shown in Table II. It should be noted that the boiler, furnace, and grate efficiencies do not include the heat of superheat which would increase the efficiency about five per cent. Since the heat of superheat is included in none of the calculations, the figures given are a true measure of the comparative value of the coals and grates tested. The use of boiler, furnace, and grate efficiency for a comparison of grate values is justified because the same boiler and furnace were used, the grates being the only variable.

The Rosebud lignite burned with practically the same efficiency on the ½-in. and ⅝-in. round-hole grates. As stated before, this lignite could not be burned at all on the old standard, ¾-in. slotted grates with 36 per cent air opening.

The difference of efficiencies with which Red Lodge coal burned on the two round-hole grates is also very small. Designating the boiler, furnace, and grate efficiency of the ½-in. round-hole grates (57.78 per cent) as 100, the rating of the ¾-in. slotted grates would be 94.0. This rating of the slotted grates with 36 per cent air opening as 94 per cent as efficient as the grates with 13.46 per cent air opening is decided proof that the Red Lodge coal burns more efficiently on grates with restricted air openings and this was more than substantiated by observations in regular service.

The average boiler, furnace, and grate efficiency produced by burning Roslyn coal on the ½-in. round-hole grates was 54.31 per cent and on the ¾-in. round-hole grates was 56.44 per cent. Subsequent dynamometer car tests showed that Roslyn coal burned with a slightly higher efficiency on the ⅝-in. round-hole grates as compared with the ½-in. round-hole grates and any further increase in the percentage of air opening resulted in a decrease in efficiency. This leads to the hypothesis that a coal with a high percentage of ash which is heavy enough to remain on the grates does not require the air openings through the grates to be restricted as much as

* Assistant professor of Mechanical Engineering, Vanderbilt University.

One of the St. Louis-San Francisco locomotives equipped with grates having 25-35 per cent air opening

Table I—Average Proximate Analyses of Coals

Coal	Type of grate	Moisture, after air drying per cent	Volatile and combustible, per cent	Fixed carbon, per cent	Ash, per cent	Sulphur, per cent	Heating value, B t.u., per lb. Air dried	As fired
Rosebud	½-in. round-hole	8.33	35.14	46.23	10.31	0.58	10,435	8,396
Rosebud	⅝-in. round-hole	9.36	34.65	45.53	10.46	0.63	10,354	8,418
Red Lodge	½-in. round-hole	4.34	36.95	44.24	14.53	1.03	10,845	10,067
Red Lodge	⅝-in. round-hole	4.11	38.05	43.35	14.50	1.15	10,796	10,013
Red Lodge	¾-in. slotted	5.18	36.65	44.72	13.45	1.06	10,865	10,291
Roslyn	½-in. round-hole	1.42	37.60	42.63	18.35	0.37	11,628	11,325
Roslyn	⅝-in. round-hole	1.34	38.00	42.57	18.09	0.36	11,673	11,367
Roslyn	¾-in. slotted	1.16	37.98	43.39	17.48	0.41	11,801	11,401

a coal with a lower ash content. The accumulation of heavy ash on the grates furnishes a resistance to air flow which decreases the amount of resistance required in the grates.

Tests on the St. Louis-San Francisco

The possibility of advantageously restricting the air openings more in certain portions of the grates than in other positions as a means of improving firing conditions by equalizing the combustion throughout the firebox has been demonstrated by another series of experiments which were conducted on the St. Louis-San Francisco. The results of these experiments were published in the April, 1930, issue of the *Railway Mechanical Engineer* and are briefly summarized here.

Table II—Boiler, Furnace, and Grate Efficiency

Type of Grate	Air opening, per cent of grate area	Boiler, furnace, and grate efficiency, per cent: Rosebud	Red Lodge	Roslyn
½-in. round-hole	13.46	44.52	57.78	54.31
⅝-in. round-hole	15.07	43.93	56.91	56.44
¾-in. slotted	36.0	...	54.31	56.65

The mechanical department of the St. Louis-San Francisco was faced with the problem of successfully burning several different varieties of coals in the same locomotives. Extreme difficulty was sometimes encountered in maintaining a new fire in the rear portion of the firebox equipped with the old standard grates with 35 per cent air openings until the speed of the train had increased sufficiently to permit the cut-off to be shortened with the resulting decrease in the draft. To reduce the chances of having holes torn in fire, the fireman running out of certain terminals always built up "heels" in their fires although the "heeling" of the fire was not recommended. The use of the thickness of the fire bed as a means of equalizing combustion results in clinkers, banks, and generally poor firing conditions if carried to excess.

The tests definitely established the fact that the draft in the rear of the firebox was greater than that in the front and that the setting of the draft plate had little or no effect upon this ratio. The substitution of increased resistance to air flow through the rear grates in place of thicker heels was accordingly made to eliminate the need of "heeling" the fire. The air opening in the rear of the firebox was reduced to 25 per cent while the 35 per cent air opening through the front grates was retained. This arrangement of grates was made the standard practice in 1928, and is unchanged except for some further restriction through the rear dump grates.

Investigation of Draft Distribution in Locomotive Firebox at Vanderbilt University

Further verification of the naturally uneven distribution of air to the front and rear of the firebox has been made at Vanderbilt University. The apparatus used was a slight modification of a device, described by H. L. Parr of Colorado University in Mechanical Engineering of June, 1937. He calls this device a "fluid-flow analyzer." It is used to show the lines of air flow past scale models to demonstrate the effect of streamlining, and has been found accurately to duplicate results obtained in wind tunnels with full scale models. As constructed, it does not measure actual velocities excepting as they can be followed with the eye.

Fig. 1 shows the essential features of the fluid flow analyzer. It is a wooden box on top of which two pieces of plate glass are spaced ¼ in. apart. An exhaust fan operated by an electric motor pulls air between these pieces of glass past the cross section models as shown by the photographs. A trough containing liquid titanium tetrachloride is located near the air inlet, as shown. Slots are cut at equal intervals along the trough so that the streamers of "smoke" are carried into the air streams as they move past the trough.

A model of a cross section of a locomotive firebox was cut from rubber and placed between the sheets of plate glass. The streamers of titanium tetrachloride delineated the paths of travel of the air through the firebox model. Photographs were taken illustrating several different conditions in the firebox.

Fig. 2 shows the paths of the gases through a firebox not equipped with an arch. The velocities toward the front of the firebox were very much greater than those in the rear. This was much more pronounced than can be shown by a photograph showing the moving streams

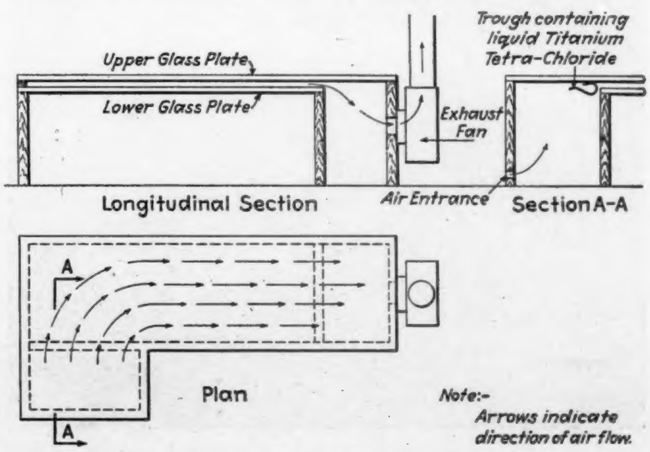


Fig. 1—The fluid flow analyzer

as being static. The disparity in the volumes taken in through the front and rear of the firebox is indicated, however, by the much larger area covered by the streams from the front of the firebox than by those from the rear after the gas has approached the tubes and the velocities of the various streams become more uniform. The gas from the seven rear slots fills only the top four tubes, while the gas passing by the front four slots occupy the bottom four tubes. This is a visual demonstration of the reason for the fire being pulled in the front of the firebox when the locomotive has no arch. The fuel under these conditions would burn much more rapidly at the front of the firebox; and the firemen were fortunate that, before arches were common, fireboxes were small and the firing distance to the front of the firebox was short.

The complete failure of the various streams to mix demonstrated one reason for the superiority of combustion on arch-equipped locomotives. Without the arch there is practically no mixing of the excess combustible volatiles generated in one portion of the firebox with the excess oxygen in the stratas from the thin portions of the fire. Even with a combustion chamber, such as that in the model, the travel of a large percentage of the gases is too short for complete combustion of volatiles. The arch also improves firing conditions for other reasons, such as hastening the ignition of the fresh fuel, increasing combustion temperatures, besides mixing the various stratas from the fuel bed to some extent.

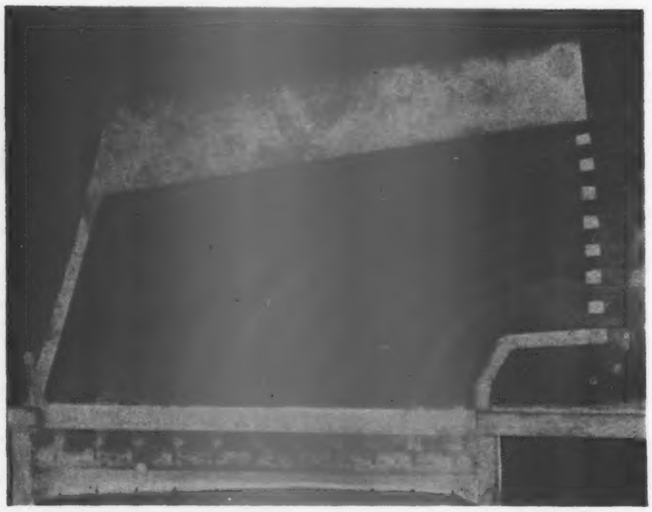


Fig. 2—The paths of the gases through a firebox without an arch

Fig. 3—The effect of the arch on the flow of gases

Fig. 3 was taken with a closed arch and with no restriction through the grates other than that introduced by the constriction of the space between the trough containing the titanium tetrachloride and the framework of the box. In this picture, as well as others taken under these conditions, the peculiar crossing of the lines of flow from the front of the firebox and those from the rear might be noted. This is evidence of the better mixing of gases when an arch is in the firebox. It is apparent that the streams of gas from the forward end of the firebox tend to increase the radius of the sharp bend around the arch and are thrown to the outside across the other streams. As was stated before, actual observance of the apparatus while in operation is much more striking than can be seen in photographs which do not show actual velocities. The streams from the rear of the firebox travel with much greater velocity than those from the front. In fact, even the photograph shows that the rate of travel and the quantities of gases in the two streams under the toe of the arch are so small that these two streams lose their identity before they traverse the length of the arch. Compared to the streams from the rear of the firebox, they scarcely seemed to move. It is apparent that a relatively small quantity of coal would be burned in this location as compared with the quantity which would be burned on an equal area of grate in the rear of the firebox. The corroboration of the draft readings obtained on the Frisco tests, showing the air flow through the rear grates to be greater than that through the front when the resistance to flow is uniform, is evident.

Fig. 4 shows the effect of opening the arch. It results in increasing the draft in the front of the firebox, tending to equalize the rate of air flow over the firebox. The mixing of the front and back streams at the throat of the arch may again be seen. The extremely short path of the gases from the surface of the fuel bed at the front of the firebox to the tubes is, however, apparent; and any slight increase in evaporative efficiency through equalizing the rate of combustion of the different portions of the grate surface will be offset by chilling a large part of the volatile gases and oxygen below the temperature of combustion before the burning is completed. One of the most apparent advantages obtained by the installation of an arch is the lengthening of the path of travel of the burning gases before they strike the relatively cold tubes. Opening the toe of the arch and short circuiting the gases from the front of the firebox to avoid excessive draft in the rear of the firebox is not desirable if the same result can be accomplished by better means. Of all the locations in the firebox, the front needs to have the travel of its gases increased most because it is the closest to the tubes. With the open arch there is no opportunity whatsoever for mixing the gases from the front and rear of the firebox, so that the rich gases may obtain some of the excess oxygen from the lean. Of course, even with the closed arch there is marked stratafication of the firebox gases, but at least there is some mixing.

Fig. 5 shows the effect of opening the firedoor. The chief result would appear to be that a strata of cold air travels along the crown sheet, partly insulating the firebox heating surface from heat transfer by convection. It might be remarked that the opening of the door when starting the train relieves the vacuum peaks to some extent, thereby preventing some of the severity of the

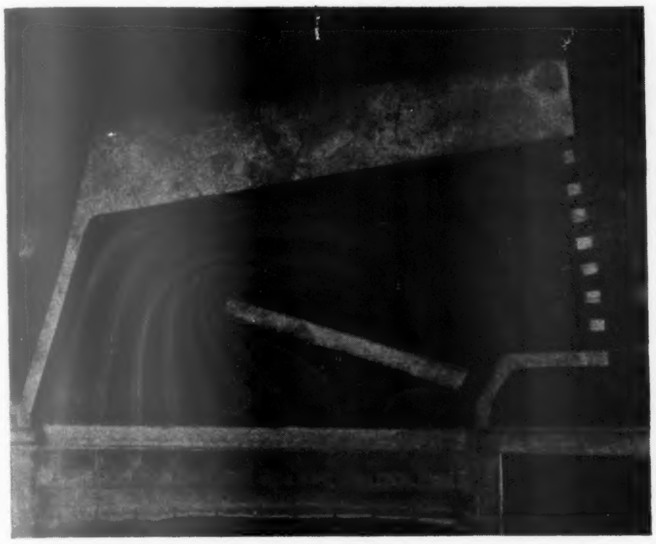


Fig. 4—There is no mixing of the gases from the front and rear of the firebox when the toe of the arch is open

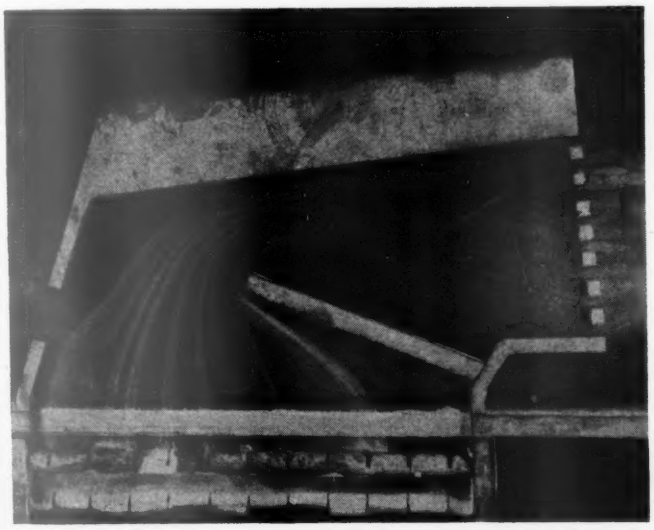


Fig. 5—The effect of opening the firedoor on the flow of gases

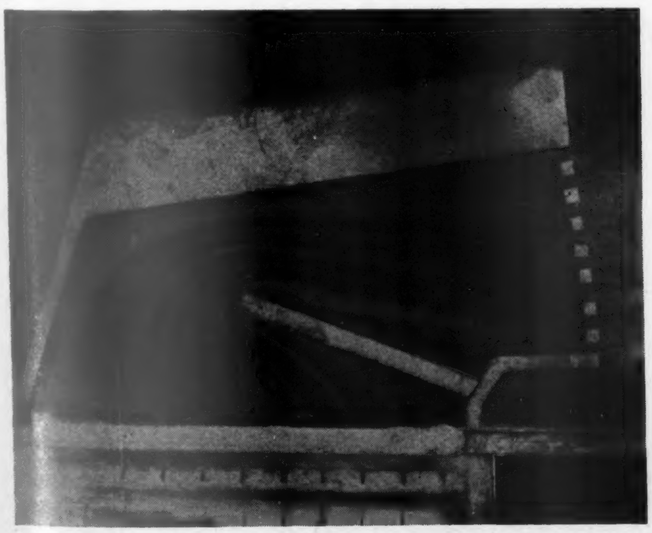


Fig. 6—The flow of gases from the front and rear of the firebox is equalized by introducing a variable resistance in the grates

tearing of the fire. This method of protecting the fire is occasionally used by some firemen. The photograph again shows the two front streams to be relatively quiescent.

Fig. 6 shows the effect of introducing a variable resistance in the grates. A strip of rubber was placed between the upper and lower sheets of glass in the position usually occupied by the grates. The strip was planed off so that the restriction in the rear of the grates back of the arch was 50 per cent and under the arch the restriction tapered from 50 per cent at the rear of the arch to 25 per cent at the toe. That is, the air opening was uniformly increased from 50 per cent at the back of the arch to 75 per cent at the front. Actual observation showed the various streams of air moving at approximately the same speed under these conditions. The picture shows that the air streams from the front of the firebox are more definite than they were before the restrictions were introduced, and their courses followed along the arch. The area occupied by the streams from the front half of the grates and the area occupied by the streams from the rear half of the grates is approximately equal when they converge back of the arch. This demonstrates the value of restricting the air opening through the rear grates to a greater extent than that through the front grates.

Conclusions

There is no doubt but that the present tendency in locomotive design is to increase the grate area, allowing slower and more orderly combustion of the coal. Some of the benefits of this increased area may be lost if the combustion is not properly controlled. The thin fires of relatively small fuel particles which have come with the stoker require a gentler treatment than the thick lump coals of the hand-fired era. Yet the locomotives are worked harder and the demands on the fire are greater. The resistance to air flow through the grate should no longer be considered an undesirable consequence of supporting the firebed, but should be used to control the rate of combustion in the various portions of the fire, and to modify the blasting action of the exhaust at long cut-off.

The adjustment of the draft plate does not throw the higher draft from one portion of the firebox to another. It merely levels off the peaks of draft resulting from the intermittent exhausts, and as such might be required to supplement the air restriction through the grates. The Northern Pacific, however, has dispensed with draft plates entirely upon some of their locomotives, and a great many roads could profitably relieve the constriction under the draft plate, replacing it with a much less severe restriction through the grates.

Restricting the grates more in the rear of the firebox than in the front tends to equalize the combustion rates throughout the firebox. An ideal application would be one where the resistance through the grates plus the resistance overcome by each stream of gas as it follows its path around the arch and through the tubes would be equal for every portion of the firebox. The difficulty of exactly achieving this result is not justification for failing to equalize the air flow to some extent.

The use of restricted air openings through the grates does not necessarily mean a reduction in the diameter of the nozzle tip. In fact, the area of the nozzle might be increased in some cases, with a consequent reduction of back pressure in the cylinders. If the air is admitted evenly throughout the grate area, less excess air will be needed, requiring the movement of a smaller volume of gases. Banks and heels may be done away with in some

(*Continued on page 148*)

A Proposed

Combustion-Turbine Locomotive*

Report of a committee of the Railway Fuel and Traveling Engineers' Association sets forth specifications for a combustion turbine combined with hydraulic torque converter and hydraulic coupling, and worm-gear drive

More than ten years ago the Steam Turbine and Condensing Locomotive Committee recommended and proposed a design for a type of motive power which would have a uniform continuous torque or flow of power to the driving axles and eliminate vibration. The motive power proposed was a steam turbine used almost exclusively in large power generating plants. A design of such locomotive with this kind of power has recently been built and is undergoing further development.

A new method of power generation has been developed during the last five or six years in that a practical method of utilizing an old heat cycle was discovered in connection with work on superchargers for internal-combustion engines. This is the gas turbine, or more correctly a combustion turbine, as it is operated by the products of combustion. Several plants using the combustion turbine are operating in this and foreign countries and the horsepower developed by such plants runs into the thousands.

This type of combustion turbine has been developed by Brown, Boveri & Company, Ltd., Baden, Switzerland. The engineering director of this company, Dr. Adolph Meyer, read a paper at an Oil and Gas Power Division session of The American Society of Mechanical Engineers, at the semi-annual meeting in San Francisco in July, 1939, on The Combustion Gas Turbine, Its Present Stage of Development and Prospects for the Near Future.† In it the author states that Brown, Boveri & Company has an order from the Swiss Federal Railways for a 2,200-hp. combustion-turbine locomotive and this locomotive is under construction.

The very promising reports from combustion turbines in service and the engineering possibilities of this development so interested the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., that this company has made not only a thorough check of this design and construction, but has actually tooled up and built several of these combustion turbines in sizes from 3,000 to 6,000 hp.; these are in service in several of the large oil refinery plants. The Allis-Chalmers Manufacturing Company has taken out a license to manufacture the combustion turbine in this country. Furthermore, it has spent a very large amount of time, energy and money during the last two years developing designs for the application of the combustion turbine to a locomotive. These designs have been developed for application of the combustion turbine with electric transmission and also with mechanical transmission in order to have complete information as to weight, cost, efficiency, and general practicability of the two types of transmission.

In his paper referred to above, Dr. Meyer said: "An interesting application of the gas turbine is the gas-turbine locomotive. It is well known that the efficiency of a steam locomotive is only of the order of 8-12 per cent, the latter figure allowing for all improvements made in the course of the last few years. The gas turbine with its coupling efficiency of 17 to 20 per cent finds here a promising field of application, since it should be possible to obtain an efficiency of approximately 15 per cent with mechanical transmission, or approximately 14 per cent with electrical transmission. These efficiencies do not naturally allow for competition with the Diesel engine, but the difference between the fuel consumptions of the two machines is in many cases fully compensated for by the difference in the costs of Diesel oil and fuel oil. Moreover, in many cases the possibility of getting more power from a given size of locomotive is of greater importance than the efficiency. Since about twice the output of a Diesel-powered locomotive can be installed in a corresponding combustion-turbine locomotive the latter, in many cases, deserves due consideration from this point of view. Another advantage, compared with steam locomotives, is the fact that the gas-turbine locomotive needs no water, thus doing away with cleaning of boilers and interruptions of service resulting therefrom.

"In the case of electrical transmission, only the gas-turbine part is new, the generators, motors, and switchgear being adopted from the Diesel-electric locomotive without modification. The gas turbine which drives the generator through gearing can always be operated at the most suitable speed for the compressor (this is also true for the mechanical transmission) so that the engine gives a high efficiency at all speeds and loads. Such a locomotive is, of course, heavier and more expensive than one with mechanical transmissions, but since it will be necessary to provide, in addition to the forward turbines, reverse turbines or corresponding reversing gears, difficulties may have to be overcome, especially in case of high outputs with the mechanical transmission."

The statements in the above quotation indicate a preference for the electric transmission for one reason, that the designs are already developed and the equipment can be standardized with that in service for Diesel locomotives, while the mechanical transmission would require development.

After full consideration of all factors in connection with the two types of transmission, it was decided to make a proposal for the installation of the mechanical transmission to a combustion-turbine locomotive and, in order to compare it with existing steam and Diesel-electric-powered locomotives handling modern high-speed passenger trains, it was decided to make such proposal to cover a locomotive of 5,000-hp. capacity. It was decided to use a two-speed hydraulic transmission in duplicate, one for forward, the other for reverse motion.

* An abstract of a report of the Turbine and Condensing Locomotive Committee presented before the meeting of the Railway Fuel and Traveling Engineers' Association held at Chicago, October 17, 18 and 19, 1939. L. P. Michael, chief mechanical engineer, Chicago & North Western, is chairman of the committee.

† See Mechanical Engineering (A. S. M. E.) for September, 1939.

Combustion Turbine

The cycle of operation is shown in the drawing and includes a heat exchanger, not shown on the main construction diagram. The cycle of operation can probably be best described by referring to the diagram in the upper left corner of the drawing.

To place the equipment in operation, first switch on the starting motor which, through an extension shaft, turns the axial compressor, turbine and generator. The compressor draws in air at an assumed temperature of 68 deg. and at atmospheric pressure and compresses it to about 45 lb. gage, and in so doing heats it to about 365 deg. F. when up to speed. This heated air then passes on to the burner and mixes with fuel oil sprayed into the space around the ignition point. An electric ignition system is to be provided. Combustion then takes place in the space at the left of the ignition point inside the burner jacket and continues on into the combustion chamber.

Inside the burner jacket the combustion temperature may rise to 3,300-3,600 deg. F., but these gases of combustion are cooled by mixing with the air at 365 deg. F. moving leftward through the annular space around the burner jacket into the combustion chamber. The gases of combustion are thus cooled to about 1,000 deg. F. before passing on to the gas turbine and are exhausted through the turbine blading to the atmosphere at about 600 deg. F., or they may be passed through a heat exchanger as indicated in the combustion cycle. In round figures, when using a gas turbine of 10,400 hp. and operating the equipment as referred to above with turbine and compressor efficiencies of about 84 and 83 per cent, respectfully, a net of about 2,500 hp. can be developed after deducting 7,900 hp. required to drive the compressor. The thermal efficiency of this cycle is shown approximately in the diagram. The speeds of the compressor and turbine are about 4,000 r. p. m.

Since the temperature and pressure of the gases of combustion to the turbine are about 1,000 deg. F. and 45 lb. gage, respectively, when no heat exchanger is used, the approximate efficiency will be found on curve *1* immediately above the compression ratio *3*. It is about 15 per cent. With combustion air preheaters (heat exchangers) using the exhaust gases from the turbine to preheat this air, the efficiency of the cycle may be increased considerably, depending on the amount of preheating surface and the final temperature of the air to the burner. This is shown on curves *2, 3,* and *4,* curve *4* indicating an efficiency of about 25 per cent maximum.

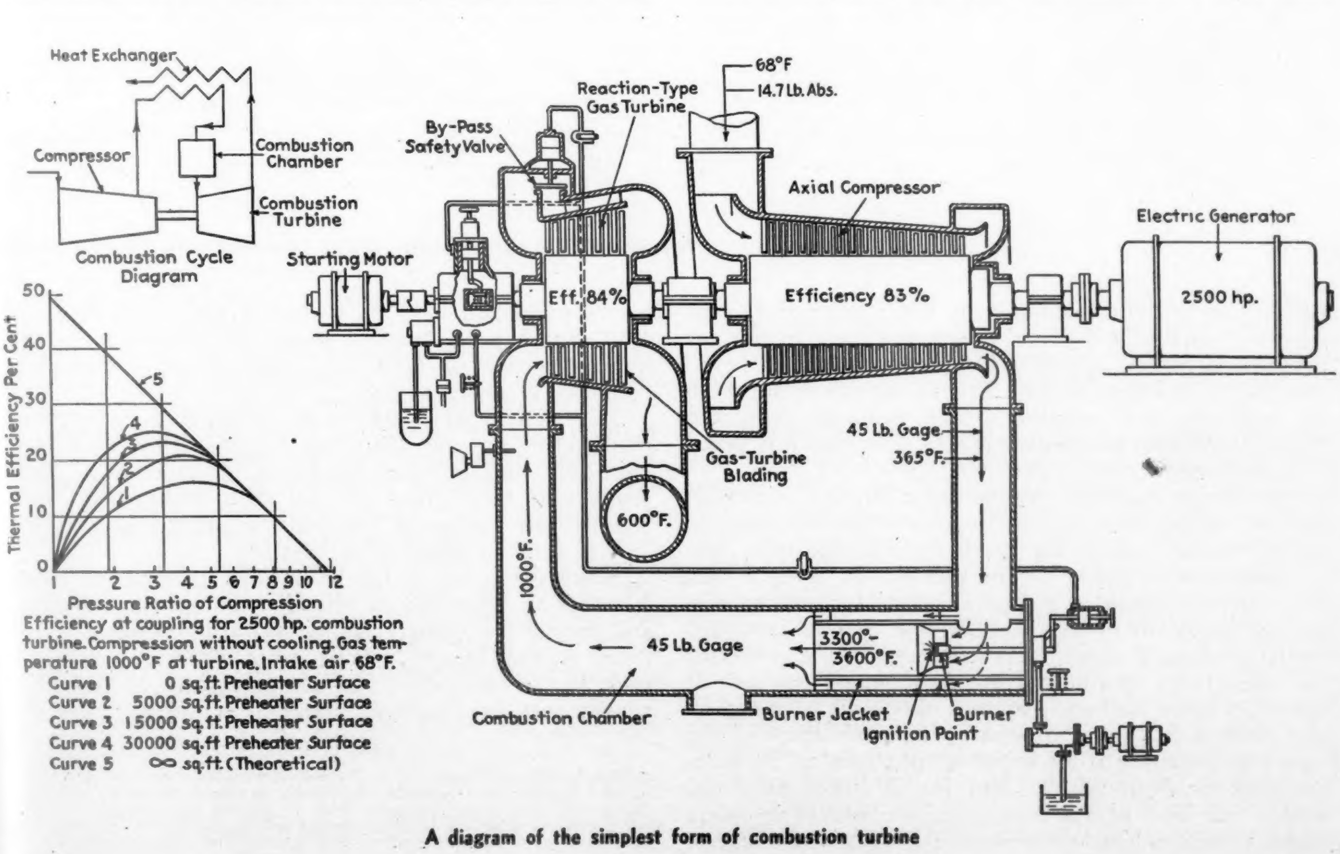
Dr. Meyer, in his paper referred to above, states that with combustion gases to the turbines at 1,200 deg. F. and suitable preheaters and reheaters between two turbine stages, an efficiency of about 33 per cent can be obtained. This is approximately the same as claimed for a Diesel engine. In the closing paragraphs of his paper Dr. Meyer says:

"The prospects of the gas turbine, if it is possible—as the author believes it is—to raise the temperature in the near future to 1,200 deg. F., can be readily appreciated. This belief is based upon the experience obtained with a number of Diesel-engine supercharging units which have been in operation for a considerable time at temperatures approaching this value, and, on tests with relatively rudimentary cooling arrangements, which show that temperatures around 1,800 deg. F. are in the realm of possibility."

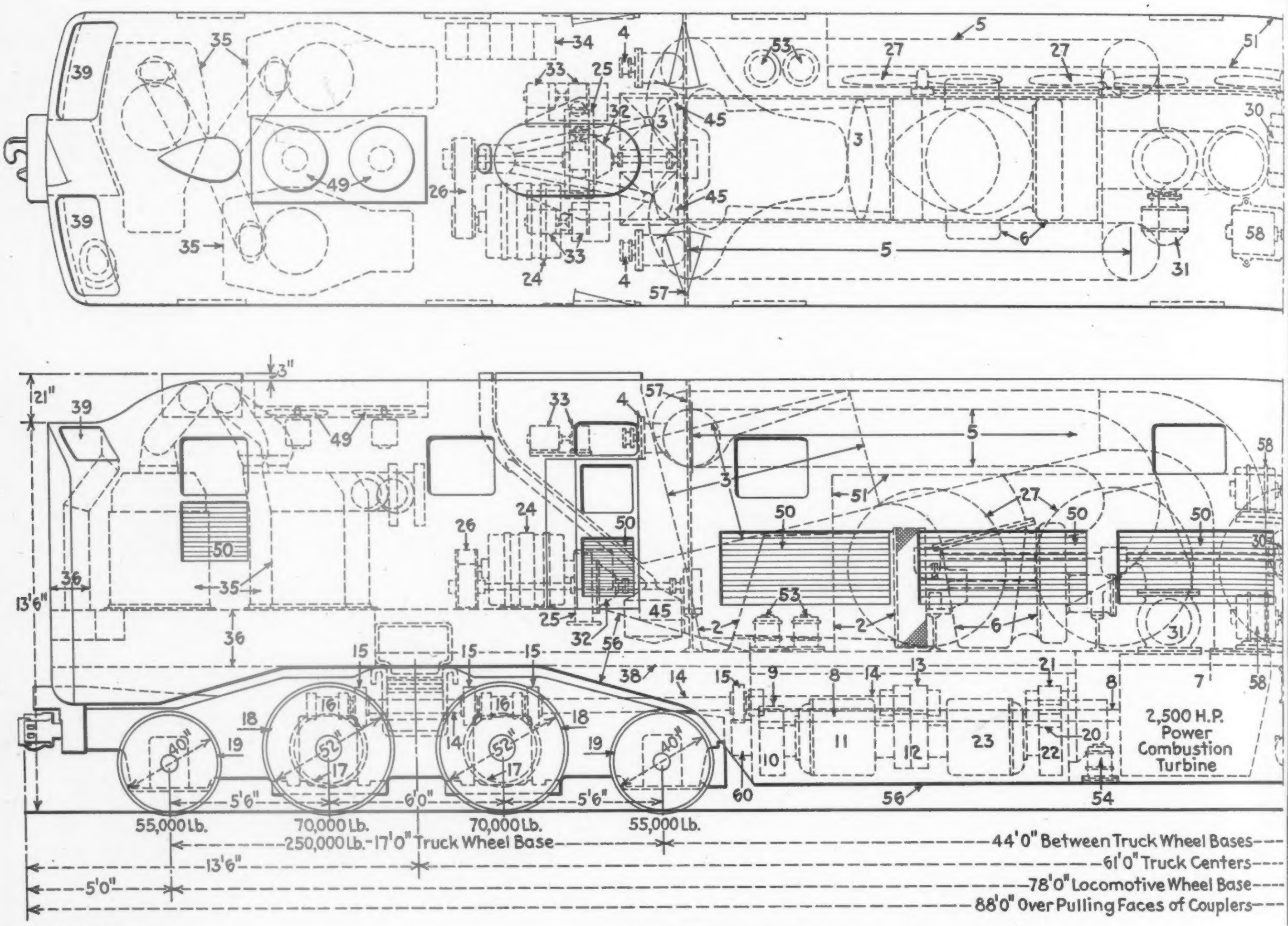
Hydraulic Torque Converter and Coupling

The hydraulic torque converter and coupling were both originated by Dr. Foettinger of Germany. The coupling was particularly developed in England by Harold Sinclair, while the combination of torque converter and coupling was perfected in Germany by the J. M. Voith Engineering Works. This equipment is now being built under license or handled by the American Blower Company, Detroit, Mich.

In the proposed designs a combined hydraulic converter and hydraulic coupling are enclosed in a common



A diagram of the simplest form of combustion turbine



1—Diesel engine
2—Combustion air compressor
3—Combustion air preheater
4—Oil burner
5—Combustion chamber
6—Main combustion turbine
7—Power combustion turbine
8—Driving shaft from turbine
9—Driving-shaft pinion, forward motion
10—Driving gear, forward motion
11—Combined hydraulic converter and hydraulic coupling, forward motion
12-13—Main power transmission gears
14—Tubular power transmission shaft (one to each driving axle)
15—Universal joints
16-17 Worm and worm gear
18—Driving wheels
19—Truck wheels
20—Driving-shaft pinion, reverse motion
21—Reverse-motion idler gear
22—Driving gear, reverse motion
23—Combined hydraulic converter and hydraulic coupling, reverse motion
24—Electric generator and starting motor
25—Auxiliary combustion-turbine power for electric generator
26—V-belt power transmission
27—Radiator fans, combustion-turbine driven
28—Radiator fan, motor driven
29—Radiator-fan combustion turbine
30—Radiator-fan motor

A proposed 5,000-hp. combustion-turbine locomotive with hydraulic transmission and

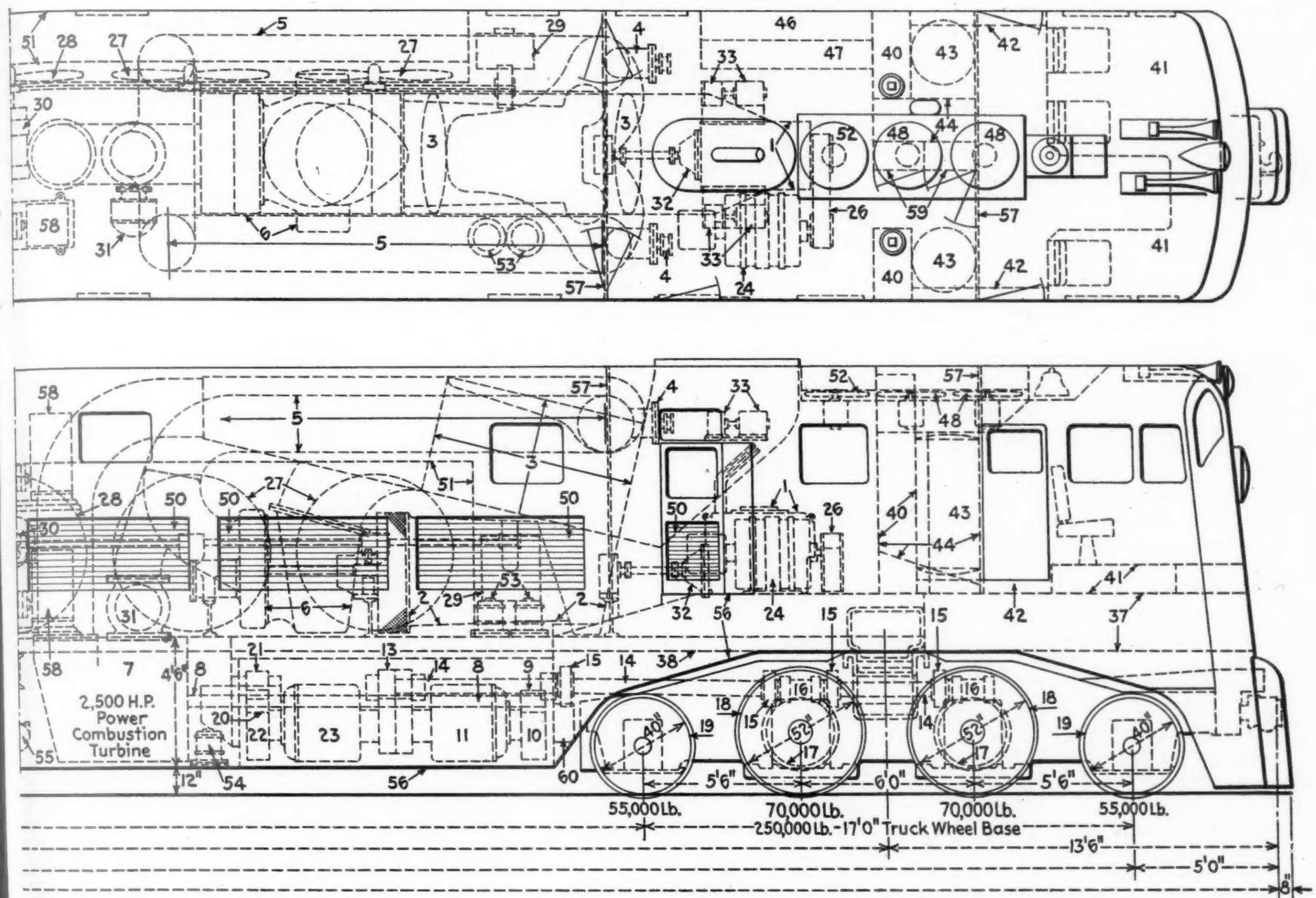
housing in such a manner that the converter can be used for starting and lower speeds and the coupling for continuous higher speeds. The driving shaft is keyed directly to the impellers or driving members for both the converter and coupling. The runners, or driven members of both the converter and coupling are keyed directly to the driven shaft.

The torque converter, as the name implies, is used to convert or increase the torque of the driven shaft to nearly double that of the driving shaft, but with considerable loss of power at low speeds. In other words, the converter operates at low efficiency at starting and at low speeds in order to obtain the desired increased low-gear starting effect. The efficiency of the converter increases from zero at starting to about 84 per cent at about 35 miles an hour and then drops off to about 77 per cent at 50 miles an hour. The efficiency of the coupling increases from about 89 per cent at 50 miles an hour to about 98 per cent at 120 miles an hour, under full load of 1,250 hp. for the size of coupling used. The combined unit is only 29½ in. in diameter over flanges and 27½ in. long, but will transmit up to 1,500 hp., but with slightly lower efficiency than for the nominal rating of 1,250 hp. The efficiency, however, increases at lower ratings.

The method of operation is to admit a light transmission oil flowing (but not under pressure) to the converter, the impeller blades of which are of such shape that they throw the oil with multiplying force against the blades of the runner, driving it and the driven shaft to which it is keyed.*

When the speed of the locomotive increases to about 50 miles an hour, the oil supply is cut off the converter and the oil in it quickly drains outward and drops to the lower portion of the housing, from which it is pumped back to the oil cooler. In the meantime oil has been admitted to the coupling. This oil is thrown from the

* Except for efficiency losses, the horsepower input and output in the torque converter are the same irrespective of speed differentials between the driving and driven runners. This is effected by stationary reaction blading attached to the housing through which the oil returns from the driven runner to the intake of the impellers on the driving shaft.—Editor.



31—Butterfly throttle valve to combustion power turbines
32—Hydraulic-coupling clutch
33—Oil-burner fuel pump
34—Electric storage battery
35—Train steam-heating boilers
36—Train steam-heating water storage, 1,600 gal.
37—Train steam-heating water storage, 1,600 gal.
38—Water-filling and equalizing pipe between storage tanks 36 and 37
39—Water-filling man holes
40-41—Diesel-engine and train-heating-boiler fuel-oil storage
42—Fuel-oil filling and equalizing pipes between storage tanks 40 and 41
43—Compressed-air reservoirs for air brakes
44—Sand storage for front truck
45—Sand storage for back truck
46—Electric switchboard locker (above)
47—Train-control mechanism locker (below)
48-49—Motor-driven turbine lubricating-oil cooling fans
50—Air-admission louvers
51—Radiators for transmission and reduction-gear oil
52—Motor-driven fan for Diesel-engine cooling
53—Turbine lubricating-oil pumps
54—Oil circulating pumps
55—Fuel-oil transfer pump
56—Combustion fuel-oil storage (5,000 gal.) also lubricating and transmission oil storage
57—Bulkheads
58—Motor-driven air compressors
59—Clothes lockers
60—Brake drums

worm-gear drive — Starting tractive force, 70,000 lb.; maximum speed, 120 m.p.h.

impeller vanes against the runner vanes and transmits power in so doing.†

To cut off the power from the coupling the oil is shut off and is automatically discharged quickly from the coupling. There is no metal contact between the impellers and the runners and the oil, when being used, is pumped continuously through a cooler and back to the converter or coupling, whichever is being used. When there is no oil in the converters or couplings, they turn freely with only air windage resistance.

The reverse motion sets are idling and turning in the opposite direction and at the same speed as the driving sets and the windage losses in power are only 2 per cent at 85, 3 per cent at 100, and 5 per cent at 120 miles an hour, and there are several practical methods of considerably reducing this.

The maximum speed of the converters, couplings, worm and driving shafts will be 3,000 r. p. m.

The turbine shaft drives the forward-motion pinion, which in turn drives a gear on each of the two converter and coupling shafts, on the opposite end of which are mounted gears which drive other gears on the driving shafts to each of the truck driving axles, two per truck.

On each driving axle is mounted a worm gear which is driven by a cone worm mounted on a shaft which extends from the hydraulic transmission carried on the main locomotive frame. Suitable universal couplings are mounted on each driving shaft to permit movement of this shaft due to movement of the driving axles.

As far as can be determined, this hydraulic transmission will have a higher efficiency at the higher speeds of the locomotive and will stand more abuse than an electrical or a direct gear transmission. The hydraulic transmission cushions all shocks between the driving axle and the turbine and forms an equivalent to a differential between the two driving axles on each truck and thus makes it possible to run with a reasonable difference in the diameters of the two pairs of driving wheels even though they are driven from the same driving pinion

† The coupling has a constant torque ratio irrespective of speed differentials between the driving and driven runners.—Editor.

on the turbine shaft. It also permits a rugged, practical dynamic brake on all driving wheels which will work in conjunction and harmony at all times with the automatic air brakes. This should greatly reduce driving-tire and other wheel-tread wear.

The cone type worm and worm gear proposed are manufactured by the Michigan Tool Company, Detroit, Mich., and are of the lightest weight but of the most rugged and efficient construction it is possible to obtain and, according to records, will give long life with low maintenance cost.

The universal joints will be furnished by the Spicer Manufacturing Company, Toledo, Ohio, one of the largest manufacturers of this type of equipment.

A 5,000-Hp. Combustion-Turbine Locomotive

The construction of the proposed locomotive consists of a long steel fabricated main frame and cab carried on two eight-wheel trucks having cast-steel frames. Two pairs of driving wheels and two pairs of load-carrying or guiding wheels are provided for each truck. Both driving and guiding axles are to have roller bearings located between the wheels. This locates the wheels outside the frames so that steel tires can be used on the 52-in. driving wheels and replacement of the driving tires can be made without dropping the wheels away from the truck frame. This permits the changing of tires instead of the changing of the entire unit of wheels, axles, journal boxes, driving worm, gear housing, etc. The guiding wheels are to be rolled steel 40 in. in diameter.

The length of the locomotive over pulling faces of couplers is to be 88 ft. and the overall width and height of cab 10 ft. 2 in. and 15 ft. 3 in., respectively.

The maximum weight on each truck at the rail will be 250,000 lb., making a total of 500,000 lb. for the locomotive in working order. The starting tractive force will be 70,000 lb. and the maximum speed 120 miles an hour.

The main frame will be of welded-steel construction with storage compartments for carrying 5,000 gallons of fuel oil, 3,000 gallons of water for train heating, and 1,000 gallons of Diesel fuel oil for the starting Diesel engine and the three train heating boilers.

The fabricated-steel frame will be of well-type construction at the center to provide space for the two driving combustion turbines and the two hydraulic transmissions, one such set for each of the two trucks. Either truck may be operated separately.

The starting of the first power unit is to be accomplished by means of a small Diesel engine. The starting of the second unit will be done by a small combustion turbine connected by combustion gas pipes (not shown) from the first power unit.

The small auxiliary combustion turbine will furnish power to drive an electric generator for lighting, battery charging, auxiliary motors, etc., and also for train cars if so desired. The small Diesel starting engine will also be coupled to an additional electric generator to be used as an auxiliary when the locomotive is standing or the combustion turbines not operating, or to furnish additional electric current when required. No auxiliaries are driven from the two power turbines.

Five large fans, one motor-driven and four turbine-driven, are provided for cooling the transmission oil for the hydraulic converters and couplings. This cooling for the transmission is considered ample for slow-speed operation in hot weather and will be less than required for the same power with Diesel engines. Five other small motor-driven cooling fans are to be furnished, one for the Diesel engine cooling and four for turbine bearing oil cooling.

Two standard motor-driven air compressors of 80 cu. ft. per min. capacity are to be used to furnish compressed air for brakes.

Three steam boilers of 2,250 lb. per hour capacity at 200 lb. pressure will furnish steam for train heating.

The advantages which the committee sets forth as possible of attainment with the combustion-turbine locomotive may be briefly summarized as follows. No water will be required except for train heating. Low-priced Bunker C fuel oil can be used at a cost per gallon of about half that of the more refined Diesel oil. Locomotives with capacities up to 6,000 hp. can be built in single units instead of two or three as required with the Diesel. The resulting reduction in locomotive weight should make it possible for a 5,000-hp. combustion turbine locomotive to handle the same train as a 6,000-hp. Diesel locomotive with the same combined weight-horsepower ratio. The locomotive is free from reciprocating parts and has the least number of parts and equipment to service, inspect, and maintain. The combined cost of fuel oil and lubricating oil for a 5,000-hp. combustion-turbine locomotive should be approximately one-third less than that for a 6,000-hp. Diesel locomotive required for the same train. Not only will the reduction in the number of wheels, axles, journal boxes, brakes and couplers, and steam, air, and water connections favorably affect the first-cost comparison with Diesel locomotives, but will reduce the amount of servicing and maintenance as well as the amount of store stock which will have to be carried. The possibilities of burning pulverized coal are greater with the combustion-turbine locomotive than with either the steam or Diesel locomotive.

Flow of Air through The Locomotive Grates

(Continued from page 143)

instances, and the constriction under the draft partially eliminated. Open arches may be discontinued so that the flame travel from the front of the firebox will be lengthened by forcing the gases to travel around the arch instead of passing directly into the boiler tubes without allowing time for complete combustion. There is another point which warrants serious thought. The grates in the majority of locomotives slope from the rear toward the front. This evidently was done to aid hand firing, making it easier to reach the front of the firebox with the coal. This aid is not required by the stoker. There is a tendency for the vibration of the locomotive to jolt the fire from the rear of the grates to the front, increasing the resistance of the front part of the fire through the addition of the ash from the rear. This increased resistance is at the point of the least draft, and compounds the effect of this reduced draft in retarding combustion. Some railroads have levelled their grates and have obtained good results.

While considerable progress has been made, there is still much to be done before locomotive drafting may be reduced to an exact science. It is much easier to obtain results, however, when the proper function of each of the various appliances is understood, even though the exact measurement of the effect of a given amount of adjustment is not known. It is apparent that proper grate design is a major factor in drafting locomotives, but there has been a tendency to neglect its effect excepting where necessity has forced consideration.

Cor-Ten Hopper Cars Show Low Weight Loss

Additional data supplementing tests already reported on the relative life of copper steel and corrosion resistant high tensile steel confirms the earlier claims of longer car life when high tensile steel is used.

An eastern railroad weighed 100 hopper cars designed for handling coke when they were delivered and again after 40 months of service. A second group of 100 cars for similar service, built of U. S. S. Cor-Ten Steel, were likewise weighed as received and again after 31 months of service.

The average initial weight of the copper-steel cars was 54,390 lb. as compared to 41,978 lb. for the Cor-Ten bodies. After an average life of 39.8 months the average weight of the copper-steel cars was 53,158 lb. while the Cor-Ten cars after 31.2 months of service averaged 41,570 lb. These figures show a loss of weight for the copper-steel cars of 1,232 lb. or 30.94 lb. per car per month as against 408 lb. or 13.05 lb. per car per month for the Cor-Ten units, indicating that cars built of Cor-Ten lose weight less than half as rapidly as do similar copper-steel cars.

The cars under test were all equipped with rolled-steel multiple-wear wheels. No specific information is available regarding the difference in weight of wheels on these particular cars at the first and second weighings. It has been definitely established, however, that no substantial proportion of wheels was replaced on either class of cars.

On the basis of the records obtained it is conservative to estimate that the loss in weight of Cor-Ten is only 42 per cent of that found for copper steel, and consequently, that Cor-Ten will last at least 2.37 times as long as copper steel of equal thickness.

Design of Diesel Locomotives

(*Continued from page 136*)

Allison metal is being used for the pressure side of crankshaft bearings with Satco metal in the non-pressure half of bearings. The capacity of lubricating oil pumps has been increased. Air for engine radiators is now carried through ducts eliminating dirt from this source getting in the enginerooms.

These improvements make it possible to run a Diesel engine 100,000 miles in road service before it is dismantled for inspection.

Wheels have been greatly improved. The service life of present wheels is about 250,000 miles with about 84,000 miles between machinings.

A crankshaft crank-throw grinding machine, designed by J. P. Morris, general mechanical assistant, was built on the Santa Fe and is now used at important terminals where the work of regrinding crankshafts is done. It will grind the crank throws of either a V-type or vertical engine. This machine has been developed so that it takes care of this work on all types of Diesel engines in service at the present time. With this machine, we expect to make 1½ million miles in road service before removing crankshafts from the Diesel engines.

It was also considered necessary to design and build a six-wheel truck having the traction motors located on the No. 2 and No. 3 wheels, using the front wheels of the new design of truck to guide the locomotive. Two locomotive units have been equipped with this type truck and the performance has been satisfactory.

The Diesel-electric locomotive is giving a good account of itself in switching and high-speed passenger service which has resulted in further activity among locomotive builders. A 2,000-hp. passenger locomotive, powered with two 1,000-hp. four-cycle Diesel engines has been built and placed in service. Exponents of the mechanical transmission, using torque convertors, have been busy and placing in service several locomotives. There is also on test a 5,400-hp. freight locomotive powered with four two-cycle, 1,350-hp. Diesel engines. All these new developments will be watched with interest, especially the freight locomotive which is invading a field in which the steam locomotive was thought to be supreme.

During the short development period through which the Diesel locomotive has gone we have seen the transition from a single-engine-powered car of 600 hp. to locomotive units having two Diesel engines of 1,000 hp. each and operation of these locomotive units in multiples of two or three units making a Diesel locomotive of 4,000 to 6,000 hp.

In view of the past performance and improvements, we have a right to expect that future Diesel locomotives will be still more economical to operate and have greater continuous load capacity combined with less weight.

* * *

One of the three 4,000-hp. Diesel-electric locomotives recently built for the C. B. & Q. by the Electro-Motive Corporation—140 ft. long, weighs 308 tons—Driven by four General Motors 12-cyl. 2-cycle, V-type Diesel engines (two in each unit) developing 1,000 hp. per engine at 800 r. p. m.

EDITORIALS

Winter Weather and Brake-Rigging Failures

Epidemics seem to be part of life in most places where human beings live together and they're not uncommon in the railroad business. If it isn't an epidemic of hot boxes, which breaks out almost any time during the year and particularly in the springtime, it may be broken springs or slid-flat wheels. At any rate it's always something and this winter was no exception. Several of our mechanical department friends have complained about the unusual number of failures of brake beams and other truck rigging parts.

When an epidemic breaks out it is only natural that every effort should be directed toward getting at the source of the trouble and correcting it. In a case like this it is not unnatural to suspect at first that possibly there may be something faulty in the design of parts or in the manner of their application but a little investigation usually discloses the fact that the difficulties did not occur on any particular design or on the equipment of any particular road.

There are many factors which conspire against the railroads in the matter of truck failures in extreme winter weather. From the standpoint of materials it is obvious that metal parts are more easily fractured at low temperatures and the loads that are imposed on these parts may be more severe in winter operation. Rough track and out-of-round wheels set up serious vibrations that are transmitted to brake beams and brake hangers and the accumulation of ice and snow on the roadbed may easily provide the means for a blow from a piece of ice heavy enough to break a part under such conditions.

The prevention of mechanical failures, irrespective of the character of equipment, is to a large extent in direct relation to the adequacy and efficiency of inspection. When car trucks are covered with ice and snow and the thermometer is down around zero it is virtually impossible for a car inspector to do as good a job as can be done in warmer weather. This fact can not be used as the excuse for a poor job of inspection, for nothing less than 100 per cent can be considered worth while, but it is a fact that has to be faced with the realization that winter operation sets up conditions that demand more careful inspection than may be needed in less severe weather.

Take the matter of worn brake hangers, for instance. Every road has set up standards as to the limit of wear before they should be replaced. Regardless of the fact that the truck may be covered with ice, an inspector must keep constantly in mind that under the ice may be a brake hanger worn to the limit. If he passes it by and its worn condition contributes to its breakage then a train delay may result.

It may be stepping out into deep water to suggest that the transportation department may in some measure be partly responsible for many of the failures of freight-car equipment that are charged to the mechanical department but it might be well for transportation department men—despatchers, trainmasters and yardmasters—to remember that, if a train pulls into a terminal yard in zero weather a half-hour or an hour late and they expect to get it "out of town" in 30 minutes, the chances are ten-to-one that a thorough job of inspection is not going to be possible. A good inspection job in the train yard takes more time or more men in winter than in summer. As to the parts that actually fail, only a consistent study of the nature of the failures in relation to the design and the materials used will permit such changes in design as are necessary to adapt the parts to the rigors of the unusual condition.

Locomotive Condition as Reflected by the I. C. C. Report

Each year, the Bureau of Locomotive Inspection makes an annual report of its activities to the Interstate Commerce Commission which is both comprehensive and illuminating. High points of the report for the fiscal year ended June 30, 1939, were outlined in an article in the February *Railway Mechanical Engineer* and indicated a general improvement in the condition of both steam and other types of locomotives operating on railroads in this country.

One of the things not included in the article, on account of lack of space, was the relative standing of the various railroads as regards the condition of locomotives examined by the I. C. C. inspectors. The Bureau report lists by individual roads the kind and total number of defects found, locomotive ownership reported, number of locomotives inspected, locomotives found defective, percentage of locomotives inspected found defective and number of locomotives ordered out of service. Perhaps the most significant of these figures is the second last, namely, the ratio of locomotives found defective to those inspected, and a study of the records on this basis presents some interesting facts.

Eliminating the smaller railroads and considering only those with ownerships exceeding 300, 500 and 1,000 locomotives, the three roads in each class which showed

the lowest percentages of defective locomotives are rated in the following order in the 1939 report: (Over 300 locomotives) Wabash, Texas & Pacific, Nickel Plate; (over 500 locomotives) Seaboard Air Line, St. Louis-San Francisco, Missouri Pacific; (over 1,000 locomotives) Burlington, Southern, Illinois Central. Some remarkable records have been made in reducing the percentage of locomotives found defective, and the Wabash, for example, which now occupies a leading position among the larger roads, reduced its figure from 72 per cent in 1924 to 0.4 per cent in 1939. Almost equally spectacular improvements have been made on some of the largest railroads which do not always achieve the lowest percentage figures, due primarily to large ownership of locomotives operating on widely-extended lines and not so easy to supervise. For example, the Pennsylvania, with 4,292 locomotives, reduced its percentage found defective from 73 per cent in 1924, to 7 per cent in 1939. The New York Central, with 3,241 locomotives, reduced its figure from 50 per cent in 1924 to 7 per cent in 1939. In general, by far the great majority of all railroads have made quite impressive reductions in percentage of defective locomotives over a period of years.

Just what does a low percentage of defective locomotives, as shown in the reports of the Bureau of Locomotive Inspection really mean? How much significance may be attributed to these comparative figures? While a favorable rating is undoubtedly highly creditable to any railroad, it is by no means the sole criterion on which locomotive condition should be judged. In the first place, the locomotive boiler inspection law covers primarily defects which have a bearing on safe operation and no attempt is made to check or evaluate those factors which influence the capacity, efficiency or ability of a locomotive to do a good day's work. For example, as long as boiler inspections and tests are made on time and indicate full compliance with the law, the government inspector doesn't care whether the brick arch is in the best condition to promote efficient combustion, or the feedwater heater functioning to reclaim the maximum number of heat units from the exhaust steam. External steam leaks are watched with a hawk eye, but the inspector does not look for steam leaks in the front end which may seriously interfere with drafting. Similarly, the inspector does not concern himself with the setting of valves which govern steam distribution to the cylinders and, as long as wheel-tread contours and lateral play are within the specified limits, he doesn't care particularly if incorrect counterbalance conditions cause the locomotive to kink rails every time it operates above a certain limiting speed.

Considering those details of locomotive condition which are covered by the boiler inspection and safety-appliance laws, it is inevitable that some of the rules should be of more vital importance than others and some, in fact, have only a very minor bearing on safe operation. No two men could be expected to see exactly eye to eye on these details and, consequently, the human element enters very largely into the question of inspecting locomotives for compliance with the federal law. It is obvious that the mechanical supervisors, especially on relatively small roads, are in a position to study the characteristics of individual inspectors, concentrate on correcting the defects to which each man seems to be giving the most attention and thus make a good record on the books, when possibly some other rather important and undersirable conditions are being overlooked.

While the standing of individual railroads, with respect to the locomotives found defective as a percentage of those examined by the government inspectors does not always tell the entire story, even from a safety standpoint, and no real measure is given of relative locomotive capacity or efficiency, there can be no question of the highly constructive purpose served by the I. C. C. Bureau of Locomotive Inspection. Since its inception in 1911, this Bureau has proved a great boon to the railroads and effected a tremendous improvement in motive power from the point of view of safe operation. The ability and good judgment of the Bureau's inspectors are of the utmost importance and the caliber of the men now working under the direction of Chief Inspector John M. Hall is indicated in some measure by the fact that no formal appeal was taken from an inspector's decision by any railroad during the year covered in the 1939 report.

Car-Wheel Grinding Effects Economies

The subject of car-wheel grinding has occupied the attention of railway mechanical officers for many years and is at present receiving increased attention because of the urge for further economies by lengthening the effective service life of car wheels. Not only are used wheels being ground to remove slid-flat spots, but new wheels are ground by many roads to assure smooth treads concentric with the journals. The strongest kind of recommendation for car-wheel grinding is given in the Association of American Railroads Wheel and Axle Manual, which states specifically in Section 19 that this method of securing improved service from new wheels and reclaiming worn wheels presents the opportunity for savings of such magnitude that the installation of a modern machine for grinding car wheels will pay for itself in a short time. The grinding of both chilled-iron and wrought-steel wheels is recommended by authorized methods in which the entire circumference of the wheel tread is ground truly concentric with the journal. Necessary precautions include the exercise and proper care in the selection of wheels to be reclaimed and also in the use of grinding wheels adapted to produce the desired results, dependent upon the kind of metal in the different wheels being ground.

The modern car-wheel grinding machine is capable of producing a very satisfactory output. According to the Manual it is possible to grind on such a machine

an average of 16 pairs of slid-flat cast-iron wheels in eight hours, 32 pairs of new cast-iron wheels, or 20 to 24 pairs of slid-flat wrought-steel wheels. Information submitted at a recent meeting of car-department supervisors in St. Louis, Mo., indicates that one large western railroad, equipped with two car-wheel grinding machines, reclaimed over 8,500 pairs of slid-flat wheels and ground 4,250 pairs of new wheels in a period of 4½ years, the total cost of labor, material and overhead during this period being estimated at $11,000 and the net saving on slid-flat wheels alone, about $100,000. This is surely an impressive record which can, no doubt, be duplicated or possibly exceeded on other roads.

Cutting the Cost of Compressed Air

Without becoming involved in any detailed presentation of statistical data to prove the point, it is probably reasonably safe to assume that the railroad industry is one of the largest users of compressed air. It is used in both car and locomotive repair shops and in numerous installations in train yards for the operation of switches and for pumping up train lines. All of these uses require literally thousands of miles of pipe lines, most of which are of necessity placed in locations which make their inspection and maintenance extremely difficult. The result has been an increasing amount of leakage in the older installations and a consequent higher demand on the plant furnishing the air, not to mention the increased cost per cubic foot delivered at the point of use.

Many factors have combined to make the railroads conscious of the cost of compressed air. There may be some question as to which department—the car or the locomotive—deserves the most credit for the ingenuity shown in the development of home-made air-operated devices but there is no question concerning the fact that when one looks over the hundreds of shop "tools" that have an air cylinder as a nucleus it is small wonder that the average railroad repair shop needs a plentiful supply of compressed air. The very process of developing these varied devices, with their inefficient use of an expensive source of power, is one of the reasons why many railroad mechanical men, in collaboration with the engineering and electrical departments, are now making careful surveys of the whole problem of the supply and use of compressed air.

In the past the centrally located power plant has been the source of this type of power. There are still in service many steam-driven compressors supplying all of the demand for a given area. As the cost of electrical energy has decreased with its broadening use a number of the steam-driven compressors have been replaced by motor-driven compressors with the result that the cost of compressed air is more definitely related to the demand.

The demand for air depends on three factors, the consumption by tools or other air-operated facilities, the transmission losses and the waste by leakage. Consumption, as far as shops are concerned can be definitely controlled by the use of none but the most efficient tools and the maintenance of such tools in good condition; the losses in transmission and the waste by leakage can be controlled by an efficient layout of supply lines and the maintenance of such lines in good condition.

Practically every road of any size has at some time made distribution-of-power studies with the idea of determining where and how compressed air is used. Anyone who has ever made such a study is aware of the fact that a substantial part of the total supply of air never reaches the place where it is used. Leakage and line losses account for the difference. The fact of real importance developed by these studies is that in many instances, where a large proportion of the air is used at a specific point located at considerable distances from the source of supply, a substantial saving can be effected by the elimination of the long supply lines and the installation of individual motor-driven compressors of sufficient capacity to supply the needs of a single location. As an example, one such study recently made developed the fact that a certain car yard served by a 1,200 cu. ft. compressor could be served by a 300 cu. ft. machine. As a result the old, remote plant was abandoned together with a large part of the old supply lines and with a modern compressor of smaller capacity the cost of compressed air for that location has been substantially reduced.

In the zeal to reduce the expense of operation it should not be assumed that there are not uses for the older plants of larger capacity. Like all such situations each individual case should be considered on its own merits. The important thing is that every situation where power of any kind is used is one worthy of constant study and in many cases the cost of modern facilities can be offset by a high return on the money invested.

New Books

TOOL MAKING. *By Charles Bradford Cole. Published by the American Technical Society, Chicago. 413 pages, cloth bound. Price $3.50.*

This is another "how-to-do-it" book. It leads the inexperienced toolmaker from the simple facts about his personal tools and the equipment provided in the shop, to the processes of the toolmaker's craft. This is done through the actual presentation of typical jobs. These jobs are presented as finished working drawings, and the tools which they represent may be made from these drawings. The section on production tools is valuable for the more experienced toolmaker.

Jim Evans, the roundhouse foreman, bellowed like a bay steer with a hollow horn when the switch engine arrived at the roundhouse with the coach and he learned why

CIRCUMSTANTIAL EVIDENCE

***by* Walt Wyre**

DICK WHEELER, foreman of the car department of the S. P. & W. at Plainville, swore mildly when he read the two traingrams. One was from the division superintendent wanting to know why there was a perpetual shortage of cars for loading carbon black. The other was from the master mechanic stating definitely and emphatically that the allowance would not permit increasing car department forces and that overtime would only be countenanced in case of wrecks, floods, fires, and other emergencies.

While the car foreman was looking over the morning mail, the switch engine rattled down the main line four tracks across from the office. The goat was pulling two cars, one a loaded refrigerator car, and the other a cattle car. The first thing Wheeler noticed was the defect card on each of the cars. Rush jobs, both of them. The switch engine wouldn't be shoving the cars in on the rip track two hours before the usual time for switching the rip unless it was urgent. Besides, loaded reefers are always rush.

While the cars were being shoved in on number one track, the foreman was figuring who he could put on them. Six carmen was all he had on the rip track and four of them were supposed to be assigned to repairing carbon black cars, while the other two did odd jobs of repairing and occasionally helped out in the train yard when the regularly assigned inspectors had more than they could do without delaying trains.

According to the defect cards, the cattle car had a broken coupler yoke while the reefer had a cut journal that called for changing a pair of wheels.

Wheeler walked down the track to see how Charley Anderson, one of the carmen on running repairs, was getting along with a caboose that had been reported six consecutive trips by the conductor. According to the trainman's reports, taking the air gage from the dog house and placing it in another caboose was the most logical method of making the caboose serviceable. It weaved, wobbled, rode hard, had flat wheels, listed to one side, doors and windows were loose, the stove smoked, and the water barrel leaked.

If Anderson was striving for success, he had reversed the rule as usually given, because he had started at the top and was working down. He had removed all of the cupola windows together with the frames. It would take at least two hours for him to repair the windows so that the caboose could be used, and it had to run that night. No use taking him off until it was finished.

"When you get the windows fixed up, tighten that loose grab iron and let it go," Wheeler told the carman. "We'll get some of the other jobs on it next trip," he added.

The other carman, working on running repairs, was replacing some siding on a box car that had suffered a side-swipe. This car was two days overdue being finished. Wheeler decided that one more day of delay wouldn't hurt a lot, so he told the carman to let it go and get started on the defective cattle car. One of the men working on carbon black cars and his helper were assigned to the job of changing out the pair of wheels on the refrigerator car.

WHEN Wheeler returned to the eight-by-ten shack that is called an office, the telephone was ringing insistently.

It was the chief despatcher calling. Chief despatchers never have good news; when it's not bad, it's worse. Eight flat wheels on the streamlined coach coming in on the Limited was the first bit of information the despatcher offered. "And it must be ready to go tomorrow at the same time," he added.

No. 72, the hot-shot gold-ball freight that usually leaves Plainville at least two hours ahead of the Limited, was running late and would get in just ahead of the passenger train was the next thing the despatcher told the car foreman, which sounded very innocent until he said "I want to get 72 out right behind the Limited."

That meant that both trains would have to be inspected at the same time and that two carmen from the rip track would have to help with the inspecting.

Wheeler hung up the receiver and started to leave the office. Just as he reached the door, the phone rang again. "What's the idea hanging up before I finish?" the chief despatcher asked.

"Thought you had finished," Wheeler replied. "What else you got on your mind?"

"Just wanted to ask how you are coming with that reefer and cattle car."

"O. K., I guess, but the men haven't hardly got started on them yet. They were just shoved in on the rip track less than thirty minutes ago."

"Well, I want that cattle car ready to go by four o'clock and the reefer must be ready for No. 80 to pick up tonight."

"That's going to mean taking all the men off carbon black cars," Wheeler told the despatcher.

"We've got to have cars for carbon black. They've opened a new plant that will load two cars a day. If we don't furnish the cars, the T. P. & W. will."

"But——" A click in the telephone interrupted what Wheeler intended to say.

The car foreman looked at his watch. It was just ten minutes until No. 72 was due to pull in on the passing track. He told two of the carmen to let the jobs they were on go long enough to get the passenger and fast freight out of town. Wheeler went to the passenger station.

The Limited came in right on the dot with the rhythmic clickety-clack of the flat wheels of the streamline chair car sounding above the other noises of the train.

"Guess the engineer must have been a little too enthusiastic with his air," Wheeler commented when he saw the wheels.

"Where do you want to set it?" the yardmaster came up and asked the car foreman.

Wheeler scratched his head a moment while the yardmaster fidgeted. "Take it to the roundhouse."

"To the roundhouse?" The yardmaster looked as though he wondered who was crazy.

"Yes, to the roundhouse. I can save a lot of time changing wheels by using the drop-pit in the roundhouse. I'll be up there in a few minutes."

Jim Evans, the roundhouse foreman, bellowed like a bay steer with a hollow horn when the switch engine arrived at the roundhouse with the coach and he learned why. "What do they think this is a—car shed?" Evans exploded. "Besides, what does a flock of dusty butts know about using a drop-pit?"

"Don't make no difference to me," the switchman said. "I'll set it out at the stock yard to load sheep in if the boss says so."

At that moment the car foreman came in and interrupted the conversation. "Got a bunch of wheels that have to be turned," Wheeler said, "and figured we could save a lot of time by bringing the car to the roundhouse."

"How many need turning?" Evans asked.

"Four pairs."

"But I need the drop-pit for locomotives," Evans objected. "One track of the pit is already tied up with a dead engine. If you tie up the other track with a passenger coach, I'd be up against it if I had to change a pair of engine wheels."

"What do you want to do with it?" The switchman was getting a little impatient.

"I'll go talk to the master mechanic," Wheeler started to leave.

"Go ahead and shove it in over the drop-pit," the roundhouse foreman growled, "but don't make a habit of it."

THE two carmen assigned to the job of changing the car wheels were the only ones pleased. It gave them a chance to work inside where it was dry and moderately warm instead of working outside where the temperature was well below freezing and a brisk northwest wind whipped particles of snow that stung when it hit.

The streamline coach was spotted for the rear truck first and the carmen and their helpers soon had the truck dropped. The end of the car was supported by heavy wooden horses while the wheels were out.

The machinist that operates the wheel lathe wasn't quite ready to start on the car wheels when they were removed from the truck. He had a pair of drivers in the lathe to be finished first. Then when the two pairs of wheels from the truck were finished and back in place under the car, the hostler was busy and couldn't spot the coach for the other truck. The carmen disconnected brake rods and had everything ready, but couldn't do any more until the coach was spotted. Forty minutes were lost waiting for the hostler.

Just before five o'clock and quitting time, Wheeler went to the roundhouse to see how they were getting along with the coach. The wheel lathe operator had just started turning the first pair of wheels from the second truck. It would take at least two hours and that with good luck before the car would be ready to go. Two carmen and two helpers—eight hours overtime! On top of that there had been a delay waiting to get the new coupler yoke riveted to replace the broken one on the cattle car and it wasn't finished; wouldn't be until six o'clock and another hour of overtime for a carman and helper. The trainmaster had thrown two fits and was working up to another when Wheeler saw him last.

The five o'clock whistle blew just as the wheel lathe operator was ready to take the finishing cut on the pair of wheels. He stopped the machine, picked up a piece of waste and began wiping his hands.

"Go ahead, finish the wheels," said the car foreman.

"O. K.," the machinist said, "but the overtime will be charged to the car department."

Wheeler groaned, then groaned again as he figured the net results of the day. Two carbon black cars finished when there should have been six! Eleven hours overtime, figuring the machinist on the wheel lathe an hour, when there shouldn't have been any! At any rate the slid flat wheels on the passenger coach was unusual and would help explain some of it. He shrugged his shoulders and started back to the office. There was still a few reports to be finished before he could call it a day and go home.

Next day wasn't so bad. Five carbon black cars were O. K.'d and there wasn't any overtime. Wheeler was beginning to breathe a little easier. That night he was sleeping peacefully dreaming of a steam heated car shed that had plenty of room, a traveling overhead crane and other conveniences. He was just adding an air conditioned room for painting cars when the rattle of the telephone tore down the whole outfit.

It was the second trick despatcher calling to tell him that the same streamline chair car had slid the wheels again and would have to be cut out.

"Set it out. I'll make arrangements to have the car taken to the roundhouse first thing in the morning."

The first time the wheels were slid flat, the blame was placed on the engineer handling the train. The next time it was decided that the trouble was perhaps in the braking system of the car and the blame was on the car department.

Wheeler instructed his air man to check everything on the car that might possibly cause the brakes to stick and take no chances.

"It looks peculiar to me," the air man said, "that it should always wait until it's on this division to slide the wheels."

"That's right," Wheeler agreed. "It does seem peculiar that it would run O. K. nearly three thousand miles then start sliding the wheels. Wonder if by any chance it was the same engineer in both instances.

Investigation showed that Dick Harrison was the hoghead pulling the Limited both times the wheels were slid, and, peculiarly enough, Harrison wouldn't ordinarily have been running on the east end. He had traded runs for one trip with another engineer for some unknown reason.

The trainmaster, all hot and bothered, came to the roundhouse while the car foreman was arguing with the roundhouse foreman over using the drop-pit again.

The air man had pushed his portable test cart to the roundhouse and was waiting for the car to be pushed into the roundhouse when the trainmaster came in. The official had learned about Harrison being engineer on the Limited both times the coach wheels were slid.

"You'd better find some defect in the air," he told the air man, "or else Mr. Harrison may get a nice long vacation."

"Harrison is a good engineer," Wheeler protested.

"Yeah," Evans added, "I always thought he was one of the best engineers on the Plains Division."

"Maybe he is," the trainmaster agreed, "but looks like he has slipped twice in the same place this time. It wouldn't be so bad if everybody wasn't watching these streamline coaches."

All day long Wheeler wondered about the car, trying to figure what caused the brakes to slide the wheels. When the air man told him that the braking equipment tested O. K. that only added to the mystery.

"The new type control valve is pretty sensitive," the air man said, "but it works fine."

"Yes, but all of the engineers have been warned about them. There was a letter put out when the streamline coaches were first placed in service on the Limited."

"Well, it just looks to me like using one or two light weight cars with the rest of the train standard equipment don't work so good," the air man said as he turned to leave.

About four o'clock the trainmaster came to the car foreman's office to learn if the air on the streamlined coach had tested O. K.

"Well, there's nothing left but to hold Harrison out of service when he comes in. Maybe he can explain what caused it when we hold the investigation."

"It'll be hard to prove it was the engineer's fault," Wheeler said.

"Be hard to prove it wasn't," the trainmaster replied as he left the office.

After the official had left, the car foreman sat thinking. He knew Harrison to be a competent engineer and couldn't believe him to be entirely responsible for the trouble. The more Wheeler thought about it the more he was convinced that some defect in the equipment had caused the trouble.

Suddenly he rose from his chair and started at a fast walk towards the despatcher's office.

"Where are your train sheets for the past three days?" he asked the chief dispatcher.

"Today's sheet is on the desk. The others are in the top drawer of that desk."

Wheeler studied the sheets for several minutes, then took a notebook from his pocket and made a notation in it. Then he went to the trainmaster's office.

"Baggage car No. 2902 will be on the Limited tomorrow morning," Wheeler said rather than asked.

"I don't know off-hand," the trainmaster replied. "Why?"

"Well, I'd like for you to make arrangements to have it set out here."

"We haven't had any reports on it," the trainmaster objected. "Why should it be set out? What's the matter with it?"

"To tell the truth, I don't know of anything, but I've been doing a little figuring. Both times the wheels have been slid on the streamline coach, it was on this end of the division, this side of Sanford."

"That's right," the despatcher agreed. "And both times Harrison was the engineer."

"Just a coincidence," Wheeler said. "That is, if my theory is right. Baggage car 2902 was in the train, too, just ahead of the streamline coach each time."

"Maybe that was a coincidence. There were at least ten other cars in the train. Why pick on the baggage car?"

"Because," Wheeler said, "the baggage car just runs on this end of the division. It sets out at Sanford and again at Middleton. I'd like to check it over."

"O. K.," the trainmaster said, "but if you want to save Harrison's hide you'd better work fast. The investigation is set for two o'clock tomorrow afternoon."

Next morning suspect number two—baggage car 2902 —was cut out of the Limited and set in on the rip track. Wheeler went with the air man to make the test.

At five minutes before two o'clock, Wheeler went to the trainmaster's office where the investigation was to be held. Engineer Harrison and his representative arrived about two minutes later.

"Well, gentlemen, I see you are on time." The trainmaster looked at his watch. "The stenographer will be here in just a moment."

"I believe," Wheeler began, "when you hear what I have to say, there won't be any investigation."

"What?" barked the trainmaster.

"Yes, baggage car 2902 caused the brakes to apply and slide the wheels on the streamline coach."

"Never heard of such a thing," the trainmaster said. "But, I'm willing to learn. How did it happen?"

"Well," Wheeler said, "the more I thought the more I was convinced our friend was an innocent bystander. When I checked up and found the car only gave trouble when baggage car 2902 was with it, that set me thinking."

"What did you find?" the trainmaster interrupted.

"A leak in the train line! Just a minute, give me time, and I'll answer your question before you ask it. In the first place, the braking equipment on the streamline coach is more sensitive than that on the older style cars. In the second place, the car is lighter and does not require as heavy brake application to slide the wheels. That's my theory on it and I'd like to see it tried. The leak in the train line on the baggage car wasn't much and wouldn't ordinarily cause any trouble. I'd like to see how it works out since the defective pipe is replaced."

"Seems a little like circumstantial evidence," the trainmaster said, "but we'll hold up on the investigation until the car makes a couple of trips with the baggage car in the train."

"Thanks," Harrison said to Wheeler. "Next thing you'll be working with the G-men."

The investigation was never held and Wheeler has been too busy trying to catch up on carbon black cars and explaining overtime to think about it any more.

Maybe it was the leaky train line that caused the wheels to slide, then again maybe the engineer unloaded twenty brownies for the first offense and an investigation with possible dismissal for the second.

What do you think?

Air Brake Questions and Answers

D-22-A Passenger Control Valve (Continued)

555—*Q.—What causes the adjuster to lock?* A.—If the adjuster crosshead is allowed to work out to the outer end of the adjuster body it will become locked.

556—*Q.—In this event how can it be released?* A.—The stop screw in the end of the ratchet nut should be loosened about one-half turn, the ratchet nut rotated one-eighth turn to the right to free the pawl, and then turned to the left to let out the required slack. The workman should make certain that the stop screw is retightened.

557—*Q.—What devices are used to permit the conductor to obtain an emergency application?* A.—The B-3-B conductor's valve and the E-3 application valve.

558—*Q.—Where are they located?* A.—The B-3-B conductor's valve, with a cord attached, is located at each end of the car. An E-3 application valve is located at each end of the car and is connected to the brake pipe.

559—*Q.—How is the application valve connected to the conductor's valve.* A.—A connection from the side of the application valve is joined by a small diameter pipe to the pipe opening of the conductor's valve.

560—*Q.—How is the application valve connected to the brake pipe?* A.—It is so connected that normally, the brake pipe air flows beneath the outer area of the piston valve in the application valve through a small port in this valve to the spring chamber, thence out the side connection to the conductor's valve.

561—*Q.—Is the air pressure now equal on both faces of the piston valve?* A.—Yes.

562—*Q.—There is a valve seat on the lower end of this piston valve. With pressure equal what serves to keep the valve seated?* A.—A spring acting downward on the piston valve, which seals the atmospheric opening below the valve seat.

563—*Q.—What happens when the conductor's valve handle is pulled?* A.—The handle lever unseats the valve, permitting air to escape from the conductor's valve pipe faster than it is supplied through the port in the piston valve of the application valve. This reduces the pressure above the piston quickly with the result that the greater brake pipe pressure on its outer area unseats the valve, creating a large direct opening from the brake pipe to the atmosphere, causing an emergency application of the control valves.

564—*Q.—How many branch pipe tees are used with this equipment and where are they used?* A.—Three, one each in the brake pipe branches to the E-3 application valves and one in the brake pipe branch to the control valve.

565—*Q.—For what purpose is this device used?* A.—The purpose of the branch pipe tee is to prevent moisture that may be deposited in the brake pipe from any cause, draining into the branch pipe connection and from thence into the valves.

566—*Q.—How is this accomplished?* A.—The interior of the fitting is so designed that the outlet from the brake pipe to the branch pipe is at the top. Thus, as air passes through the brake pipe, it flows upward into a chamber and from there through the pipe opening at the side of the branch pipe, the moisture and heavy particles of dirt passing on through the brake pipe.

567—*Q.—What new type angle cock is recommended for use with this equipment?* A.—The double locking angle cock.

568—*Q.—What is the purpose of the double lock?* A.—To prevent accidental movement of the handle such as might be caused by a loose safety chain. This discourages unauthorized tampering.

569—*Q.—How is this additional protection obtained?* A.—A latch, hinged in the handle, must be depressed before the handle can be raised to unlock and turn the cock key. As this requires two distinct and opposite forces, which can only be coordinated manually, the cock is safe against accidental opening from a single force such as that applied by the foot or by a swinging chain. A spring holds the latch in engagement with the socket, locking the socket and handle together so that the handle cannot be raised to clear the stop lugs on the body.

Self-Contained Dust Collector Unit

The Cincinnati Air Master is an efficient dust collector unit that is suitable for use with all makes of grinding and buffing machines having exhaust outlets. The dust and grit-laden air is thoroughly filtered through a series of closely woven fabric and steel-wool filter bags and exhausted through an opening in the top of the cabinet. The heavier particles fall immediately into a large tray in the bottom of the cabinet and a foot lever operates a device for shaking the lighter particles into the tray which is removable for cleaning. The fan motor is regularly connected into the same switch that controls the grinder or buffer and starts simultaneously with the machine.

The motor, suction fan, and filter bags are completely enclosed in a compact, lacquer-finished, insulated cabinet which is mounted on rubber feet to ensure quiet opera-

tion. A metal partition prevents the entrance of dust and grindings into the motor compartment.

The unit is furnished in two sizes, the type AIR-1 for wheels up to 10-in. diameter by 1½-in. face, inclusive, and the type AIR-2 for wheels over 10-in. diameter to

The Cincinnati Air Master dust-collector unit

14-in. diameter by 3-in. face. The units are furnished complete with the piping from the exhaust outlets on the grinder-wheel guards or buffer hoods. The Air Master is made by the Cincinnati Electrical Tool Co., Division of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio.

My Idea of a Stock Car*

By D. V. Costello

Being responsible for the conditioning of stock cars for loading at the National stock yards, I have observed conditions which I feel could be corrected by attention to certain mechanical details.

Stock-Car Side Slats Should Be at Least 1⅛ In. Thick.—As I have observed, cars with slats less than 1⅛ in. thick, are too light for cattle, horses and mules. Very often we have mixed loads which include a few bulls, and they must be tied in the car. They are invariably tied to the slats. Lumber lighter than 1⅛ in. thick often will not hold the animals. We also have a condition daily, of cars arriving with built-in home-made partitions, nailed to the light slats. Very few arrive intact, most of them being down in the car. No doubt we all have noticed that light lumber will not withstand the flexibility of cars; it splinters and breaks.

Stock-Car Side Slats Should Always Be Bolted.—In our daily practice, going in and out of stock cars, conditioning them for stock loading, we note that cars with bolted side slats are always in better shape than nailed slats. We have to carry different size nails, for we are sure to find side slats loose and some down in the car. We also find lots of nails broken off and protruding. You can clean a car with nailed slats, free from all protruding nails and on arriving at destination, the other fellow will find some nails that are broken off and worked out. This condition causes injuries to stock.

Edge-Grain Lumber of a Good Grade Only Should Be Used in the Spacing One Foot to Seven Feet from the Floor.—We find that a good grade of edge-grain lumber, if used in stock cars, will reduce the splintered conditions that we come in contact with daily and will prevent numerous injuries caused by splintered lumber piercing the animals flesh, which causes many claims.

Stock-Car Side Slats Should Be Spaced Three Inches Apart.—The side slats should be spaced 3 in. apart, because slats spaced 4 and 5 in. apart leave openings through which stock can get their feet, and when this happens, the animal becomes excited, falls down, resulting in bruised or broken legs. The spacing of three inches would also be economical when stock cars are used for fruit and vegetable loading, as the opening has to be closed. All we would need would be a 2-in. strip in place of a 4- or 5-in strip. That would reduce the amount of lumber that is being used and save cost in stripping.

The Interior of Stock Cars Should Be Free From Any Projections.—Numerous stock cars are equipped with end doors built inside the car. The slide rails project out about 2 in.; the fastener also sticks out and some come loose and hang down. Most of these fasteners are applied with nails or screws, which work loose and protrude. There are also cars with 3-in. rump boards, reducing the width of the car. Numerous shippers have hay placed on the floor of the car for animals to feed on, and this is where we have a bad condition. The animals, raising their heads come in contact with projecting rump boards. We also have a condition that crops up daily. Cars with broken slats have boards nailed over the broken part and nearly always they are old, rough and splintered board. Any kind of projection inside a stock car will cause injuries.

Stock Bars Should Be Between Door Posts.—A great deal of damage is caused by stock bars in loading and unloading live stock. Some stock cars are equipped with slotted stock bars that are fastened on the inside face of the door post, projecting 2 in. at a point with which stock is continuously coming in contact, when loading and unloading. Stock bars should be set in between the door posts and suspended from a chain bolted to the door post, thus being free to swing outside of the car. Some kind of a bracket should be provided for the stock bar to drop into outside of the car, thus keeping it out of the way when the car is being loaded or unloaded.

Side-Door Hasps Should Be of a Collapsible Type.—The protruding side door hasps on stock cars have caused some of the worst flesh wounds imaginable. I suggest a collapsible type hasp, one that would swing out of the doorway when the car is being loaded or unloaded. I also suggest the use of two hasps about rump board high and two hasps at the bottom of the door, thus having four hasps on each side door, instead of two. I believe that would help preserve the door from being broken and prevent injuries.

Side Doors Should Be Constructed So They Will Swing Out at the Bottom.—We have experienced considerable trouble with stock-car doors that operate in guides and rollers. I suggest that all stock car doors be con-

* Abstract of a short paper presented at the February 20 meeting of the Car Department Association of St. Louis. The author is a gang foreman on the Terminal Railroad Association of St. Louis.

structed so they will swing out at the bottom. Bedding accumulates in both summer and winter and causes delays in opening and closing the doors. I have seen car doors chopped off at the bottom in severe cold weather, so the stock could be unloaded. These doors equipped with guides and rollers very often get out of place and sometimes it is necessary to use jacks to get them in operating position. I also suggest that a strip about 2 in. by 6 in. be bolted the width of the door at the bottom so it will rest on top of the deck, this board to be eased at the top. This will prevent leg injuries at the doorway.

Cars With Metal Roofs Should Be Insulated.—During the summer we have a very bad condition in hog loading. Cars with metal roofs are stored for prospective loading. The hot sun shining down on these metal roofs causes intense heat. If these roofs were insulated and would throw off that heat, I believe we could correct that condition and save thousands of hogs. I suggest also that if the cars were constructed with higher double decks, that would be a great help. The present decks in most cars are too low, which causes considerable head and eye injuries in calf shipping.

More Attention Should Be Paid to Roofs in Regard to Leakage.—The innocent drops of water dripping through a leaky roof cause a multitude of grief. Water, soot and sulphur mixed together and dropping in on stock, especially horses and mules, when they are hot, causes the hair to fall out and I know of several claims that were paid on account of this condition. The animals also become chilled from being wet.

Consideration Should Be Given to the Use of the Same Car for Both Single- and Double-Deck Loading.—Convertible cars would go a long ways in solving the stock-car problem. Numerous times we are called upon to furnish single- and double-deck cars. If cars were equipped so that they could be converted from one to the other, it would be a good plan. When orders are placed for double-deck cars and we have to furnish single-deck cars, that doubles the number of cars, requires more track room, extra switching and per diem, and longer trains. If we had some kind of a double-deck that could be raised or lowered, and operated on a winding shaft from outside of the car, it would solve one of the problems we have today. I know of but one railroad that has this arrangement now.

The present method of constructing partitions is expensive and results in many damaged slats. Possibly cars could be constructed with a standard partition system, much the same as the cars for automobile parts loading.

Balancing High-Speed Rotating Parts

The ever-growing demand for higher operating speeds has emphasized the need for some means of quickly and accurately measuring and locating static and dynamic unbalance in revolving parts. The Gisholt Machine Company, Madison, Wis., has developed an extensive line of Dynetric balancing machines for this purpose. The smaller machines take parts weighing as little as a fraction of a pound, while the larger machines are built to accommodate much larger and heavier parts, such as, for example, Diesel locomotive generator and motor armatures, mounted car wheels, etc., in the railroad field. Several of these machines are now in successful use in railroad and equipment builders' shops. In developing them, Gisholt acknowledges the co-operation of the Westinghouse Research Laboratories at East Pittsburgh, Pa., where the first balancing machine of this type was conceived and built.

Type 3U Dynetric Balancing Machine

The Type 3U Dynetric balancer, illustrated in Fig. 1, was built to balance rotating parts of train and locomotive equipment. This machine will measure and locate the unbalance in parts up to 60 in. in diameter and 80 in. between bearing shoulders. The machine is driven by a 20-hp. induction motor through a reduction gear which gives balancing speeds of 300, 450 and 600 r.p.m.

To handle the wide variety of work encountered in transportation equipment, the machine is supplied with two sizes of work-supporting structures, arranged so as to make possible the change from one type of structure to the other in approximately 20 min. The lighter type of work-supporting structure permits of measuring and locating the unbalance in parts weighing up to 2,000 lbs. Therefore this structure is used for balancing generator armatures for car-lighting equipment, fans or blowers for air-conditioning equipment and armatures for traction motors. Thus, this lighter type of work-supporting structure will handle all equipment on which there is a volume of parts requiring maintenance. The heavier type of work-supporting structure is used for measuring and locating unbalance in parts weighing from 1,000 to 7,000 lb. This structure, therefore, may be used for car-wheel assemblies, large generator armatures and other heavy parts as well as for large traction armatures if desired. The wide overlap in weight capacities indicated greatly reduces the frequency of changing from one type of structure to the other.

The traction-wheel assembly, weighing 3,200 lb. and shown in Fig. 2, required the addition or removal of 2.025 lb. of weight at a radius of 14¼ in. on the wheel adjacent to the driving gear and required the addition or removal of 1.235 lb. of weight at a radius of 14¼ in. on the other wheel. At a track speed of 120 m.p.h. on a wheel speed of 1,120 r.p.m., these unbalances represent a force of 1,040 lb. at the wheel nearest the driving gear and a force of 680 lb. in the other wheel. These forces were present even though the wheels are rolled forgings turned all over and ground on the tread. Because of the restrictions on removal or addition of metal to car-wheel assemblies by any method which might initiate a fracture, the actual application of these corrections has not been accomplished in practice. A mechanical bonding process which will not influence the physical structure of the wheel, such as metal spraying, could possibly be used.

The traction-motor armature, weighing approximately 2,000 lb., shown in Fig. 1, required the addition of 0.56 lb. of weight at a radius of 6¾ in. on the commutator end and a weight of 0.265 lb. at a radius of 11¼ in. on the fan end of the armature. At a top motor speed of 2,200 r.p.m., these unbalances become forces of 520 lb. at the commutator end and 430 lb. at the fan end of the armature. The general method of applying these correction weights is to weld measured lengths of cold-rolled steel to the inside of the commutator shell and to the fan on the other end, the machine indicating the lengths of material required with any given cross section.

Principal Characteristics of the Machine

In the Type 3U balancing machine, the work is supported in a horizontal position in two half-bearings which carry the work on the same bearing surfaces as are used to support the work in its final assembly. These half-bearings are flexibly supported by a lightweight structure, suspended from wires, which permits horizontal vibration of the work piece.

The driving shaft or spindle carries two universal

couplings which are so designed as to offer a negligible resistance to the vibration of the work. One of these flexible couplings is attached to the machine spindle and the other is attached to one end of the work-piece. The spindle is rotated by a suitable motor drive. The machine spindle carries an angularly graduated dial *G* by means of which the angular location of the unbalance is transferred to the work.

As an unbalanced work-piece is rotated, the supporting bearing structure is caused to vibrate. This vibration is mechanically transmitted by means of wires to separate coils which are in the field of powerful double ring magnets. The vibration of the coil in the magnetic field generates an alternating voltage in the coil, and this voltage is directly proportional to the amplitude of the vibration of the work-supporting structure.

The voltages thus generated are greatly amplified so that even the most minute unbalances are distinctly indicated. A vibration as small as .000025 in. will generate a sufficient voltage to permit a reliable reading to be made. The electrical system is easily and quickly adjusted to show the exact location and amount of unbalance correction which must be applied to eliminate the vibration of the work at its bearings.

The amount and location of unbalance indications are not affected by vibrations from adjacent machinery or other external sources. The effects of external vibrations are eliminated electrically, and only the vibrations due to unbalance which occur once per revolution of the work are recorded.

How the Unbalance Is Measured and Located

The only controls used in measuring and locating unbalance in the type of work for which the Type 3U machine has already been set up are shown by letters in Fig. 1, as follows: *A*, a hand wheel on the front of the cabinet, which is used in determining the angular position of the unbalance; *B*, two weighing dials, one of which weighs the correction to be applied on the left end of the work and the other weighs the correction to be applied on the right end of the work; *C* a switch marked "left-right" for determining in which of two correction planes the unbalance is to be measured and located; *D* a switch marked "angle-amount" for selecting whether the amount of the unbalance or its angular location is to be determined; *E* a switch for setting the meter to indicate large or small amounts of unbalance; *F* and *G* graduated dials.

To balance a part for which the machine has already been set up, the work is loaded into suitable half bearings carried in the work-supporting structure. The flexible driving connection with the hinged clamps is attached to the work. The "start" button is then pushed to bring the work piece up to speed and, after an automatically timed interval, the supporting structure, which is electrically locked during the loading time, is released to allow the work to be moved by force of unbalance.

Switch *C* is moved to "Left" and switch *D* to "Angle" positions and hand-wheel *A* is turned until the meter reads zero. The pointer on the forward angularly graduated dial *F* then shows the angular location of the unbalance in the *left* end of the work. Switch *D* is then thrown to "Amount" position and the left weighing dial *B* is turned until the meter reads zero. This dial setting then registers the amount of correction required in the desired practical correction units. The switches are then

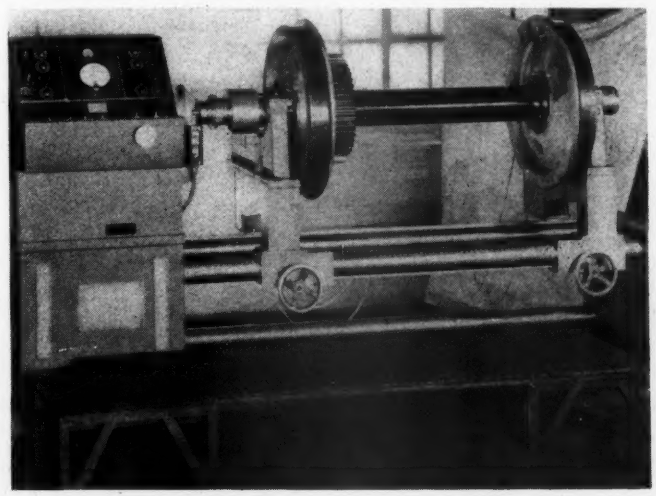


Fig. 2—Determining the static and dynamic unbalance in a pair of mounted traction wheels

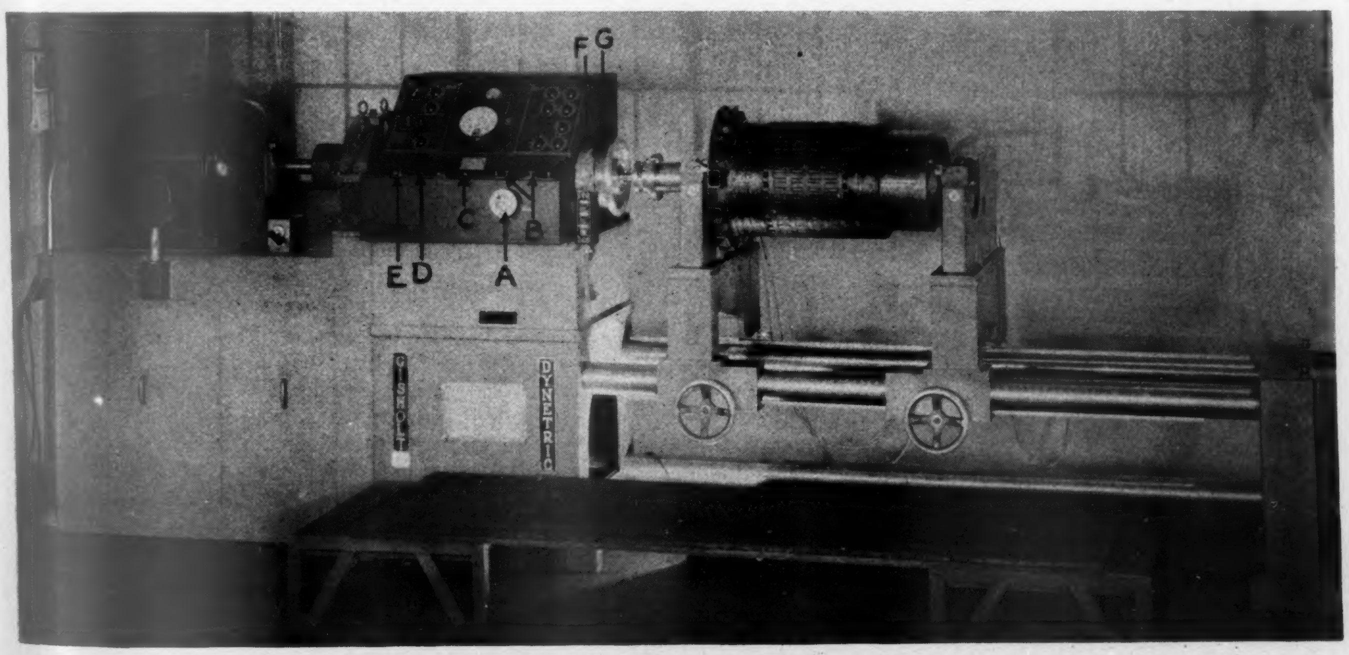


Fig. 1—Gisholt Type 3U Dynetric balancing machine being used to balance a traction-motor armature

set to "Right" and "Angle" positions and the handwheel is again turned until the meter reads zero at which time the angular location of the unbalance in the *right* correction plane will be indicated on the forward angularly graduated dial. Switch *D* is then set at "Amount" and the right weighing dial is turned so as to give zero meter reading. The dial setting will then register the amount of correction required in the *right* end of the work. The stop button may now be pushed to bring the work to rest by a magnetic brake on the motor shaft and to lock the work-supporting structure. The measuring operations can easily be completed in 20 seconds.

Now, if the "inch" button is pushed, the work can be inched around until the rear angularly graduated dial

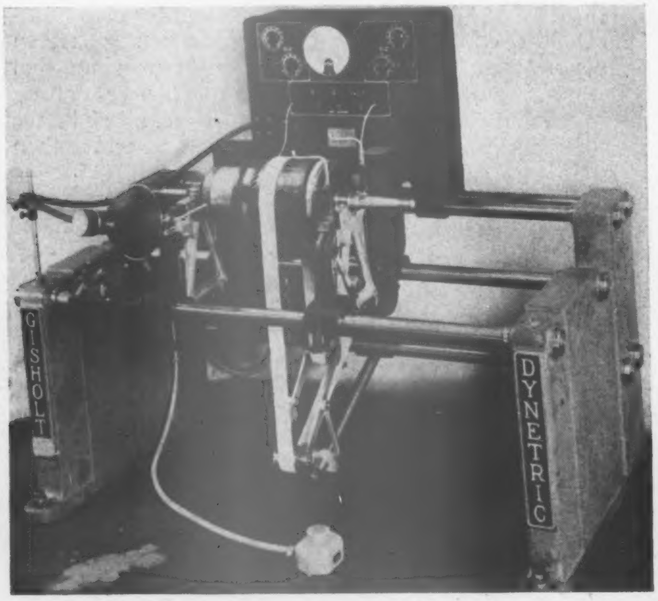


Fig. 3—Gisholt Type 3S Dynetric balancer used in balancing armatures and fans for Pullman car service

G indicates "Left Angle" as read above and the index pointer on the left work support will point out the location of the unbalance correction. Then, if the work is inched to "Right Angle" position, the index pointer on the right work support will indicate the location of the right end unbalance correction. When the correction locations are properly marked, the work may be removed from the machine to apply the correction and the unbalance may be measured and located in another part.

The dials and switches on the sloping surface of the cabinet are used only for setting up the machine to indicate truly unbalance in known practical correction units in planes of correction suitable for the work piece and at correction radii permitted by the work piece. Once these dials and switch settings have been determined and recorded for a given type of piece only a minute is required to return them to the recorded settings when that type of piece is again to be balanced. Less than 15 minutes is necessary to determine and record these dial and switch positions for a new type of work piece.

The procedure to be followed in setting these dials and switches for the first of a new type of piece is inscribed on the sloping surface of the cabinet, and as all dials and switches are numbered to suit the instructions, it is said that even an inexperienced operator can easily make the required setup.

The purpose of each dial and switch on the sloping surface of the control cabinet may be readily understood by referring to Fig. 1. The switch in the upper left corner permits of selecting the degree of machine sensitivity required. The other switch on the left side of the cabinet cuts in or out the compensating generators. These compensating generators are running only during the setting up and provide a means whereby voltages may be introduced into each of the pick-ups attached to bearing supports to nullify the effect of voltages being generated in the pick-ups due to vibrations of the work supports produced by the rotation of the unbalanced part. This brings about a condition of electrical balance and the meter will give no reading. The four dials on the right side of the cabinet permit of adjusting the compensating generator voltages to give this condition of electrical balance.

The remaining dials and switches are in two duplicate rows, one on either side of the meter. The row on the left of the meter is used for setting up to indicate unbalance in the left plane and the row on the right of the meter is used for setting up to indicate the unbalance in the right plane. The upper dials in the two rows permit of making the meter read in practical units of correction (different units for each end of the piece if desired).

The second dial in the row is the adjustment on the lever or voltage divider. The switches immediately below these dials permit of getting the proper out-of-phase relationship of the voltages for all conditions.

The remaining dial in each row permits of calibrating the "Right" and "Left" weighing dials so that they will read in desired correction units such as 0.010 ounce, 0.0156 in. of depth of a given size of drill, 0.01567 in.

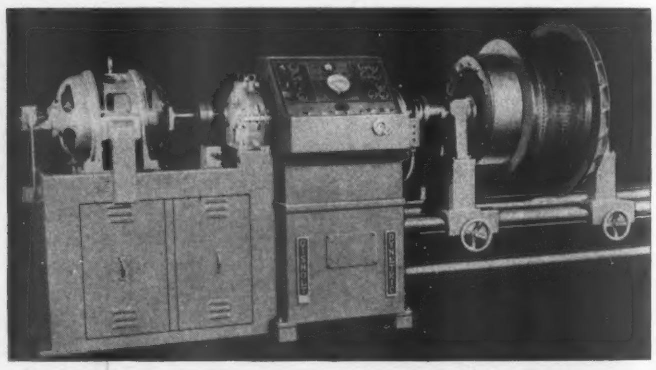


Fig. 4—Type 3U machine being used to balance a Diesel-locomotive generator armature 56 in. in diameter and weighing 5,300 lb.

of length of bar stock of known size, etc. These corrections are applied in planes of correction permitted by the construction of the work piece and at predetermined radii in each of the correction planes.

The Type 3S Dynetric balancer, illustrated in Fig. 3, is one of the smaller machines used in balancing armatures and fans for Pullman car service and will take 24-in. by 24-in. work, weighing up to 200 lb. In regular production with this machine, the time for measuring and locating unbalance is less than 30 seconds and repeat parts can be set up in about 10 min. The machine operates on the same general principle as that already described, except that the work is belt-driven and angular location of the unbalance is determined by a separately mounted Stroboglow lamp. D. c. armatures, such as that illustrated, are often corrected for unbalance by adding solder to the bonding wires at points indicated by the balancing machine.

Other Gisholt Dynetric balancers include the Type C machine for balancing parts such as crankshafts and the Type E static balancer for parts such as small flywheels, fans, pulleys, etc., in which the diameter of the piece greatly exceeds its thickness.

Canadian National Method For Lagging Application

The photographs and drawing accompanying this article show a method of applying block lagging to locomotive boilers developed by the Canadian National at the Pt. St. Charles Shops, Montreal, Que. which has the advantages of ease of application and permanence with respect to the fixtures used.

The general arrangement is shown in Fig. 1. The lagging is held by "brackets" formed by punching and bending strips of jacket steel 3⅞-in. wide and of a length to suit the diameter of the boiler course on which they are to be used. The dimensions of the openings in the finished strap and the manner of making the bends is shown in the drawing in Fig. 2 and in the photographs in Figs. 3 and 4. The completed straps are supported at the top end, on the boiler, by a ¼-in. lip over the edge of a ¼-in. x 1¼-in. flat bar which is supported in turn by the handrail post studs. There is, at each opening in the strap and at the top near the flat-bar support, a bent portion which holds the strap and the lagging 5/16 in. away from the boiler sheets.

On the average boiler there are about 25 lagging straps to each side of a barrel and firebox. These are spaced about 18 in. apart. The straps for the barrel courses are made in lengths to suit the application and will hold, for example, from 16 to 18 ordinary size blocks of lagging in the length from the flat bar support to the bottom center line of the barrel courses. The firebox straps are short ones which may hold only six or eight blocks. These straps are not fastened at the bottom.

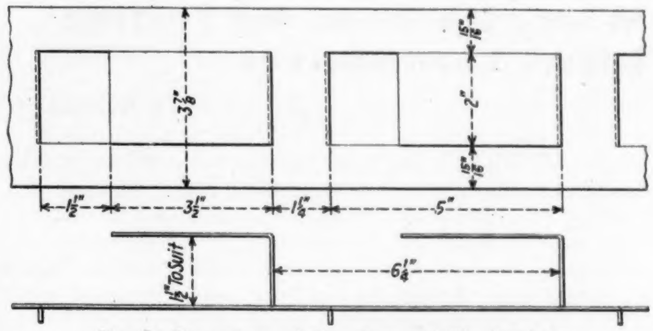


Fig. 2—Dimensions of the strap and the brackets

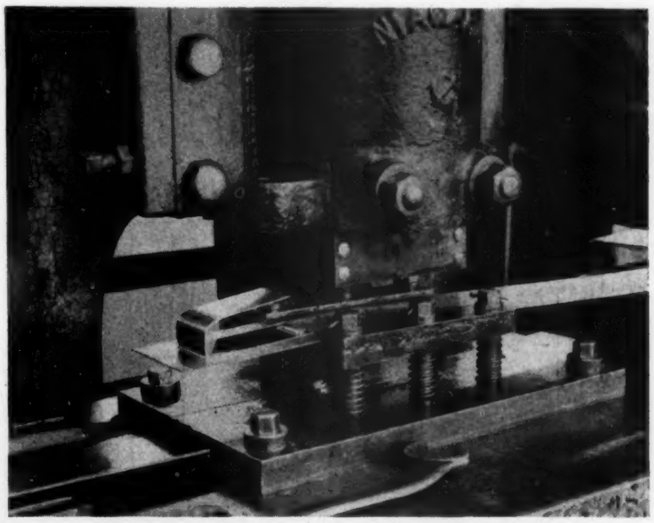


Fig. 3—Close-up of the die for punching the straps

The barrel-course straps are fitted with clips where the two straps are held together at the bottom center line. The two straps are drawn together by means of ⅜-in. bolts. The straps are made in the shops in a No. 6 Niagara punch in which a special spring die is used. Fig. 3 shows the die in the open position after having punched and bent a "bracket" opening in the steel strip. Fig. 4 shows a section of a strap with five brackets. This photograph shows the 5/16-in. leg on the back of the strap which holds the lagging away from the boiler.

This device and its method of application is protected by Canadian and U. S. patent application.

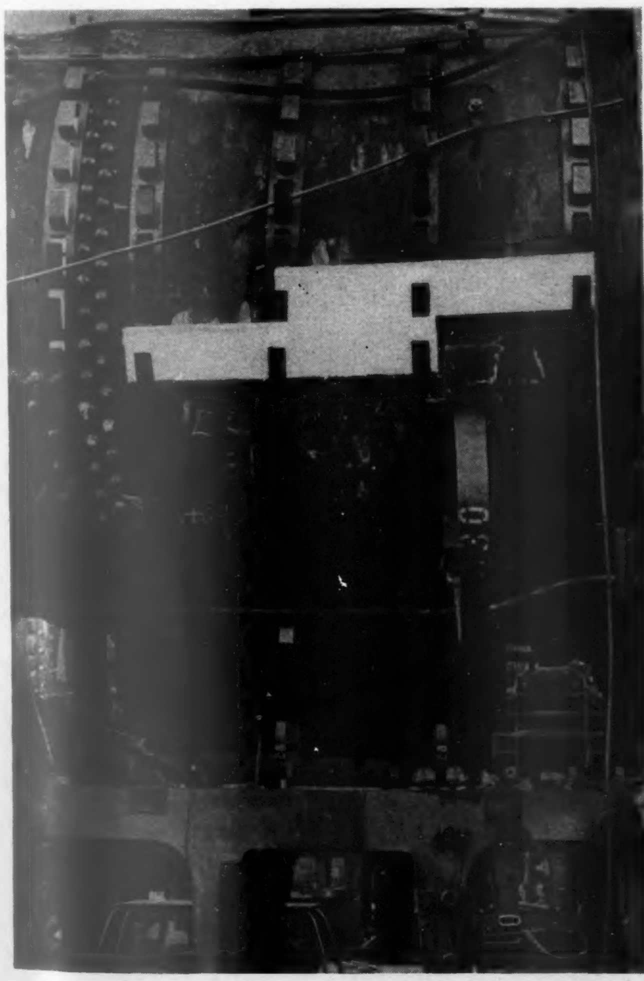


Fig. 1—General arrangement of the lagging straps on the barrel of the boiler with two blocks in position to show how they are held

Fig. 4—A section of a strap after the punching operation showing spacer legs on back of strap

Water Rheostat for Testing Diesel Locomotives

*By C. C. Whittaker**

A simple, "home-made" rheostat can be built that greatly facilitates the testing of Diesel-powered locomotives. Such a rheostat is inexpensive to build, and yet affords maintenance men the opportunity of conveniently and accurately testing new or overhauled engines under various loads. It can be made almost entirely of parts which are available in any railroad shop.

Most liquid rheostats have used various salts dissolved in water to form electrolytes, such as sodium chloride, ($NaCl$) and sodium carbonate (Na_2CO_3), the latter giving more satisfactory results because of less corrosion on the steel parts wet with the electrolyte. Because this electrolyte gets hot it is frequently necessary to add cold water and more salt to bring the temperature and conductivity of the electrolyte within operating limits. This procedure is inconvenient and causes loss of time.

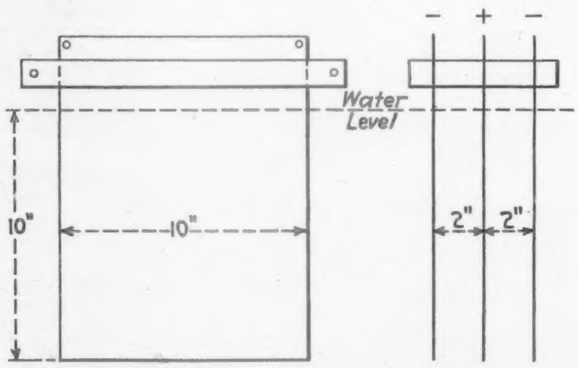


Fig. 1—Test rig for determining water resistance

The rheostat described here does not need salt of any kind, but employs tap water just as it comes from the water system. Water is permitted to flow through the rheostat continuously while the test is in progress, the amount of water being varied to suit the load. Approximately 34 gallons of water per minute will carry off the heat generated by the output of 1,000 engine horsepower, assuming 93 per cent generator efficiency and 5 per cent loss for auxiliaries.

* Railway engineering department, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

The specific resistance of tap water differs considerably in different localities. This can be compensated for in a large measure by making the rheostat of such a size that it will match the resistance of the water.

The first step in building a rheostat should, therefore, be to determine the specific resistance of the water that will be used. This can be done by means of three pieces of sheet iron 10 in. wide, 12 in. long and of any convenient thickness. All oil and grease should be removed from the plates with soap and hot water before assembly. The sheets are then spaced 2 in. apart by wood strips and clamped together by two bolts, as shown in Fig. 1. This test rig, when immersed in water so that 10 in. of the plates are below water level, will then have 100 sq. in. on each side of the positive plate, each square inch acting through 2 in. of path to a negative plate. A wood box or a steel tank may be used providing the plates are 5 in. or more away from the tank.

The resistance of the water is determined by applying 500 or 600 volts d.c. to the electrodes and measuring both voltage and current. The locomotive generator may be used for this purpose if no other source is available. The resistance of the water will be $R = E/I$. Since there are 200 sq. in. of area, each with a 2-in. length of path, one cubic inch of water will have a resistance of $200\ R/2$. Readings during the above test should be taken with the sample water at approximately 30-deg. C., since the resistance decreases as the temperature rises, 90-deg. C. water having approximately half the resistance of water at 30-deg. C.

While the readings are being taken, the water should be agitated by a wood paddle or by having water flow past the electrodes to minimize the effect of polarization.

Having determined the resistance of a cubic inch of local water, reference should now be had to the table which gives required dimensions of rheostats, built as shown in Figs. 2 and 3.

Obviously, a rheostat could be designed with such a large plate area and low current density that the plates would last indefinitely. However, the first cost and size of such a device would be prohibitive, especially for the railroad which requires only an occasional test of this kind. Accordingly, the dimensions of the design have been reduced to permit low first cost and sufficient life for railroad application.

Wherever direct current is passed through a liquid rheostat, the positive electrode is chemically decomposed over a period of time, the rate increasing with the current density of the electrodes. In the design given, the estimated life of the electrode required by 800-ohm water is 200 hours at maximum rating. A great deal of the

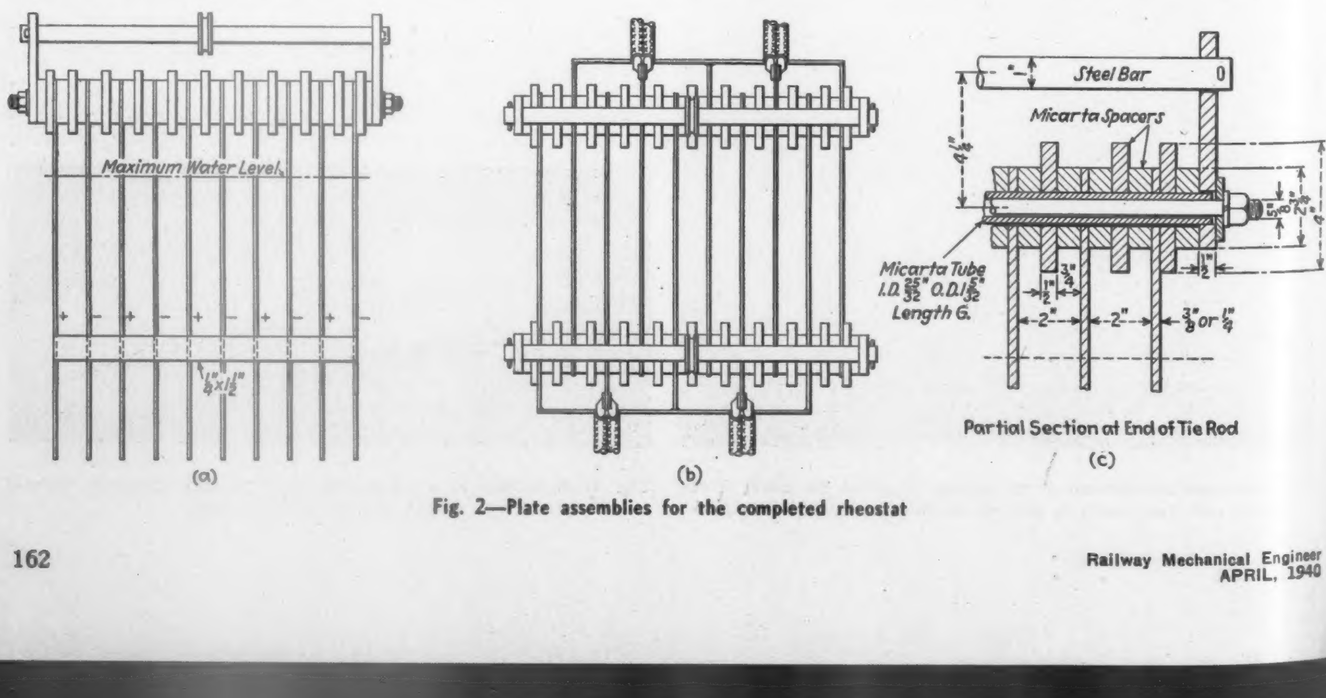


Fig. 2—Plate assemblies for the completed rheostat

testing will be done at less than full load rating so that the actual time of disintegration should be much longer than this. Frequent reversal of plate polarity should be made to wear out both electrodes uniformly. The electrodes can be made of ordinary boiler plate steel.

The Micarta insulating spacers should be dipped in Alkyd resin varnish, before being assembled, and allowed to become dry enough to handle. When assembled in this condition, and the tie rod nuts drawn up tightly, the plastic varnish coat will yield enough to make well-sealed joints between all adjacent surfaces. After the assembly is complete, all insulating washers should be given two coats of this varnish.

At full load, the electrodes must carry approximately 1,000 amperes and the cables must be sufficiently flexible to permit movement of the electrodes. It is therefore desirable to divide this current between four cables for each polarity, using 600-volt cable having 259 strands of 0.0254-in. diameter wire, the cable having a bare diameter of 0.533 in. and an overall diameter of 0.841 in. The four cables are held in split wood cleats as shown in Fig. 3.

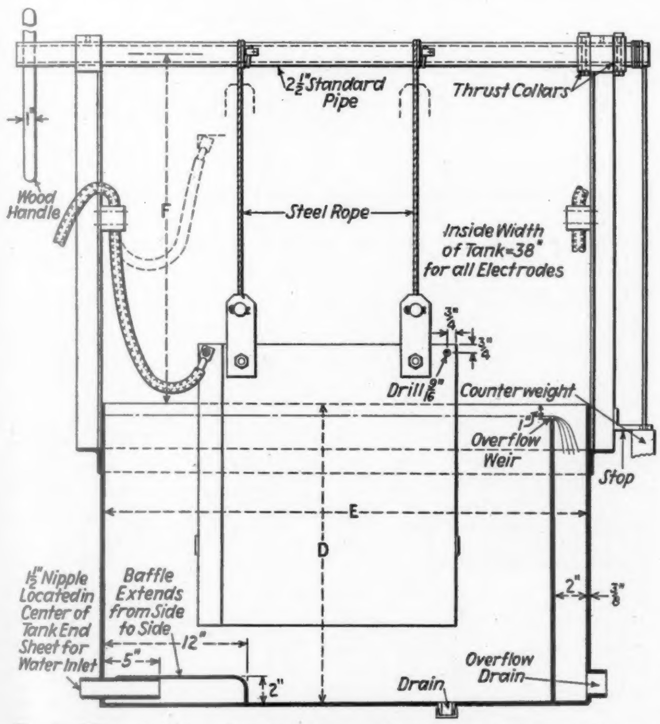


Fig. 3—The complete rheostat showing hoisting mechanism, tank and water connections

Adjustment of the height of the electrodes in the water can readily be made by hand by turning the supporting pipe by means of the wood handle. With the electrode counterweighted, there should be enough friction in the bearings to hold any given adjustment. If remote control is desired, it is a simple matter to attach a motor and gear reduction unit to the shaft.

In order to make the test set safe for operators, the tank should be grounded. This can most easily be done through the water inlet pipe.

In localities where the water is so pure that the resistance is too high to be used without excessive plate areas, the largest design shown can be used and the low conductivity of the water supplemented by the addition of sodium carbonate as found necessary. If this is done, the feature of being able to operate continuously is lost and it will be necessary to stop at intervals to replenish the electrolyte.

Dimensions of Plates and Tank (Figs. 2 and 3)

	Plate Dimensions			Tank Dimensions			
Ohms per cu. in. of water by test	Width, in. *A*	Height, in. *B*	Thickness, in. *C*	Depth, in. *D*	Length, in. *E*	Distance, top of tank to center of hoist shaft, in. *F*	Length of Micarta insulator, in. *G*
500	24	15	0.375	28	33	30	25.2
600	24	18	0.375	28	36	30	25.2
800	24	24	0.375	28	42	30	25.2
1,000	24	30	0.375	28	48	30	25.2
1,200	24	36	0.375	28	54	34	25.2
1,500	28	36	0.375	32	54	34	25.2
2,000	36	36	0.25	40	54	42	23.9
2,500	36	45	0.25	40	63	42	23.9

While the rheostat is in operation bubbles of hydrogen and oxygen will be given off. The oxygen will unite with iron electrons forming ferrous and ferric oxide. This will appear as a brown froth and will be carried over the overflow. Because of the liberation of oxygen and hydrogen, the rheostat should be located in a well ventilated space. If located out of doors, the insulated tie rod assemblies should be protected from the weather when not in use and should be given a coat of varnish if their surface shows a dry appearance.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Testing and Repairing Steam Gage

Q.—How are steam gages tested? If gages are found to show an incorrect reading, how are they fixed? Where is the steam gage connection on a locomotive boiler located?—M. I. D.

A.—The I. C. C. Laws, Rules and Instructions for Inspection and Testing of Steam Locomotives and Tenders and their Appurtenances, provides as follows:

Time of testing:—Steam gages shall be tested at least once every three months and also when any irregularity is reported.

Method of testing:—Steam gages shall be compared with an accurate test gage or dead-weight tester and gages found inaccurate shall be corrected before being put into service.

The method of adjusting a steam gage depends upon the trouble experienced and upon the accuracy desired. If, upon testing, the gage is found to be out a definite number of pounds and this discrepancy is about constant throughout the entire scale, the resetting of the hand is all that is necessary. This is accomplished by removing the gage hand with a gage-hand puller and then refiitting it to the spindle by very light hammer blows at the proper setting.

However, should there be found to be a progressive gain or loss, an adjustment in the mechanism has to be made. This adjustment, of course, is more troublesome except to an expert. Most manufacturers recommend

the gages be returned to the factory for repairs except where the user maintains a department that can properly repair and recalibrate gages.

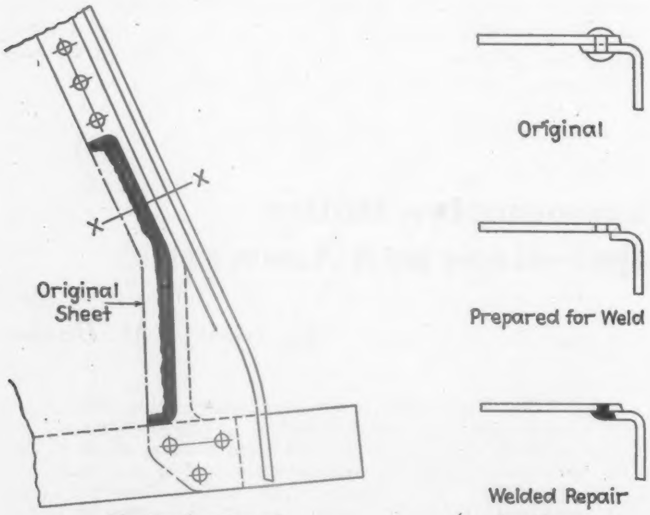
The steam gage connection in the boiler is generally located at the top of the boiler, usually in the corner radius of the backhead.

Checked and Cracked Rivet Holes in Door Sheet

Q.—We have considerable trouble with the checking and cracking of rivet holes in the firebox door sheet at the firebox corners. How can this condition be repaired?—K.F.R.

A.—There are various methods of repairing the condition outlined in the question. Although the manner of repair generally depends upon the conditions as found in each specific case, the diagram illustrates a typical repair to overcome this condition.

The door sheet is cut back far enough to eliminate the



A typical method of repairing checked and cracked rivet holes in the door sheet

existing rivet holes, after which the sheet is bevelled to 45 deg. and properly cleaned for welding. The seam is then lap welded as shown, completely filling the old rivet holes in the firebox and sheet.

The Design and Application of Stoker Tubes

Q.—How is the thickness of the stoker tube in a locomotive boiler determined, that is, the tube in the boiler backhead for the stoker distributor of a Duplex stoker. The boiler pressure is 250 lb. per sq. in. How are these tubes applied?—J. E. R.

A.—The 1937 A. S. M. E. Boiler Construction Code, Par. P-22, gives the following formulae for computing the maximum allowable working pressure for steel or wrought-iron tubes or flues for fire tube boilers for different diameters and gages of tubes as follows:

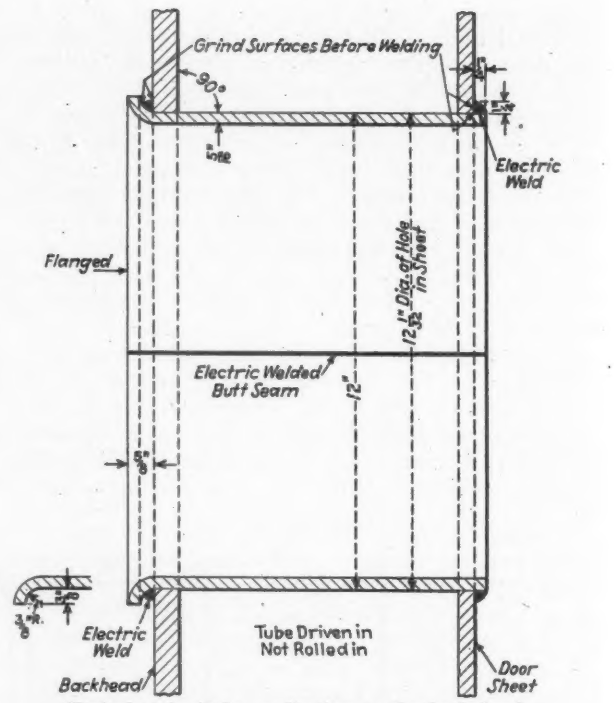
$$P = \frac{(t - 0.065)}{D} \times 14{,}000$$

where

P = maximum allowable working pressure, lb. per sq. in.
t = minimum wall thickness, in.
D = outside diameter of tube, in.

transposing we have

$$t = \frac{DP}{14{,}000} + 0.065$$



Typical stoker-tube application to the back head

Stoker tubes for Duplex stokers usually have a 12-in. outside diameter. Substituting in the formulae the values $D = 12$ and $P = 250$ we have

$$t = \frac{250 \times 12}{14{,}000} + 0.065$$
$$t = .2142 + 0.065$$
$$t = .2792 \text{ in. or } 5/16 \text{ in. thick.}$$

A typical application of a stoker tube to the backhead of a locomotive is shown in the illustration.

Rivets Required to Hold Brace Rods

Q.—A locomotive boiler backhead is supported with three 1½-in. brace rods. The brace-rod connection to the backhead consists of a 6-in. by 4½-in. T-iron. What would be the number and size of rivets required to secure the T-iron to the backhead?—K. I. M.

A.—Rule No. 3(a) of the I. C. C. Laws, Rules and Instructions for Inspecting and Testing of Locomotives, provides as follows, "The maximum allowable stress per square inch of net cross-sectional area on round, rectangular, or gusset braces shall be 9,000 lb.

The net cross-sectional area of a brace 1½ in. in diameter equals 1.7671 sq. in. The effective cross-sectional area of each brace rod must be determined by taking the angle of each brace rod, and, if in excess of 15 deg., the area of the brace must be reduced by multiplying the area of the brace by the cosine of the angle that the brace makes with a line drawn at right angles to the area supported.

Assuming, for example, that the top brace has an angle of 12 deg., the middle brace an angle of 20 deg., and the bottom brace an angle of 30 deg., then the effective cross-sectional area of the braces would be:

Top brace	1.7671
Middle brace = 1.7671 × .93969 = ...	1.6605
Bottom brace = 1.7671 × .86602 = ...	1.5303
Total effective cross-sectional area...........	4.9579 sq. in.

Maximum permissible load on braces = 4.9579 × 9,000 = 44,621 lb.

It is the practice to use ⅞-in. rivets for securing 6-in. by 4½-in. T-irons to the backhead. Assuming 50,000

lb. per sq. in. for the tensile strength of steel rivets and a factor of safety of 4, the allowable load on the rivets would be 12,500 lb. per sq. in.

Required cross-sectional area of rivets =

$$44{,}621 \div 12{,}500 = 3.5696 \text{ sq. in.}$$

In computing brace-rod connections, it is the practice to make the brace-rod jaws, eyes, brace feet, pins, rivets and angle irons stronger than the body of the brace.

The A. S. M. E. Code makes the following provisions:

Par. P-223 (8) Make the combined cross-sectional area of the rivets at each end of the brace at least 1¼ times the "required cross-sectional area" of the brace.

Required cross-sectional area of rivets =

$$3.5696 \times 1.25 = 4.462 \text{ sq. in.}$$

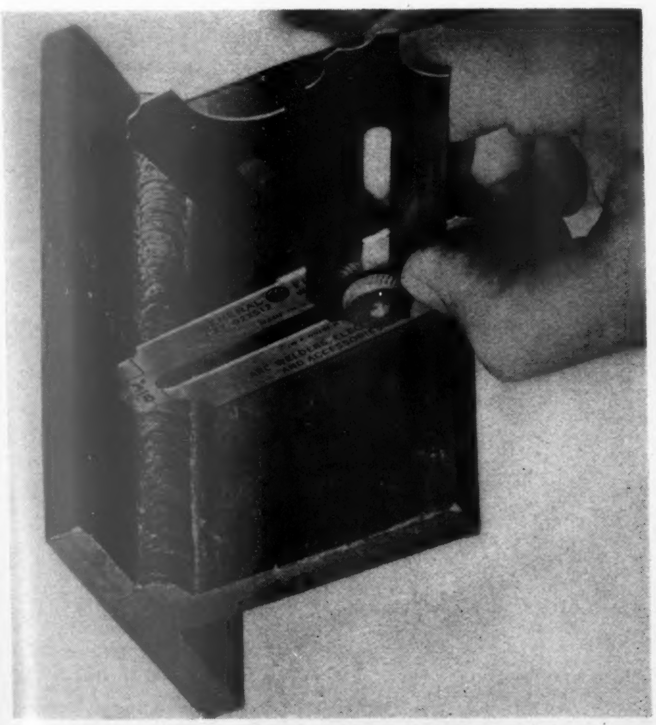
The cross-sectional area of a ⅞-in. rivet after driving would be the cross-sectional area of a 15/16-in. diameter rivet hole or .69029 sq. in.

Number of rivets required $= 4.462 \div .69029 = 6.46$

The actual number of rivets to be used in this case would be 8.

Gage for Checking Fillet-Weld Size

A fillet-weld gage has been developed by the General Electric Company, Schenectady, N. Y., to meet a need of welding inspectors and operators for a fast, accurate means of checking the size of fillet welds on work which has to meet rigid specifications.



The General Electric fillet-weld gage

The gage consists of three stainless-steel stampings held together by a bolt and knurled thumb nut. Either convex, concave or standard fillets can be checked merely by fitting the edge of the gage flush against the work so that the indicating portion of the gage rests on the weld bead. The gage can be used to check fillets of the following sizes: ¼ in., 5/16 in., ⅜ in., 7/16 in., ½ in. and ⅝ in. These sizes are clearly marked in black on the gage.

Steam Valve With A Spinning Disc

The Ostlind valve is designed to eliminate rather than resist the causes of leaky valves. The outstanding feature of this valve is a spinning disc which rotates at speeds up to 2,000 r. p. m. for a moment preceding closing. The spinning disc throws off scale and other foreign particles by centrifugal force, thereby preventing these particles from becoming caught in the line of seating. The disc hits the seat while spinning at a high rate of speed and consequently polishes the line of closure, creating a complete metal-to-metal contact between the seat and the disc. The disc does not spin when the valve is in the cracked position or while throttling the steam. A reversing chamber directs the steam flow to the turbine vanes just before the disc descends on to the seat. These vanes are shielded from the steam flow when the valve is open.

The valve is equipped with two separate seats, one for closing and one for cracking and throttling, in order that the line of closure may be protected from the erosive action of high-velocity steam and to prevent scale from sticking to it during operation. When the valve is opened one full turn from the closed position, it will be cracked from the throttling seat. If the valve is opened more than one turn throttling is effected between the side of the disc and the throttling seat. The valve is shown in the throttling position in the illustration. Further opening of the valve brings it into full open position.

The disc is mounted on the spindle against a stainless-steel ball bearing which aligns the disc with the seat when closing. The bearing will stand a temperature of 950 deg. F. and maintain a hardness of 60 Rockwell C. The valves are built in sizes from ½-in up by Ostlind Valve Inc., Portland, Ore.

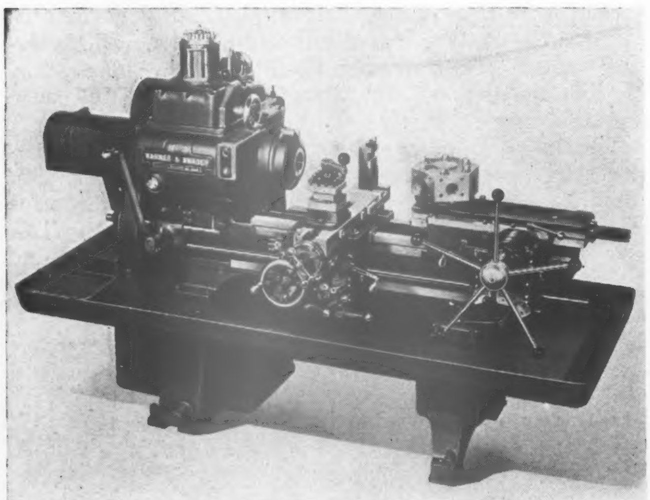
The Ostlind valve has a disc that spins at speeds up to 2,000 r.p.m. just before closure

Ram-Type Turret Lathe

A more rigid bed design, a head brake, and improved head lubrication are some of the improvements made in the new No. 4 ram-type turret lathe, developed by the Warner & Swasey Co., Cleveland, Ohio. It has a bar capacity of two inches, which is ¼-in. greater than the capacity of the No. 4 machine it replaces, and an 18⅛-in. chucking swing.

This turret lathe is equipped with the pre-selector head only, signalling the definite establishment of the pre-selector as an easily-operated, time-saving unit for reducing costs. Heretofore, the pre-selector head was available as optional equipment. With this unit only one lever is required to shift the gears and cutting operations are placed on a surface-feet-per-minute basis which materially simplifies the operation of the lathe. To further ease the shifting of the gears the location of the shifter fork was changed from the outside diameter of the gear teeth to a hub on the shaft.

To maintain accuracy during extreme cutting conditions the rigidity of the bed has been increased almost 30 per cent by a new design that features diagonal ribbing, similar to bridge truss bracing, instead of the conventional box-type ribbing. This construction also increases considerably the clearance space for chips as they fall into the pan, a matter of increasing importance as the rate at which metal is removed is increased.



The Warner & Swasey No. 4 ram-type turret lathe

The head of the machine is lubricated by a forced-feed system. With oil stored in a reservoir in the base of the machine, the lubricant is kept considerably cooler than it is in the splash system. The spindle brake, another new feature, is an improved type that can be released after the spindle is stopped to allow the positioning of chucks and fixtures.

There are six reversible power feeds, both cross and longitudinal, for the universal cross slide and the speeds increase uniformly to provide a proper range for all classes of work. The square turret indexes automatically, and the large cross-slide dial has widely-spaced graduations for accurately measuring the depth of the cut. A plunger oil pump on the cross slide thoroughly lubricates both the cross slide and the bed bearings. The hexagon turret is equipped with adjustable stops for automatically tripping the feed for each turret face, and the turret may be indexed in either direction to skip tool stations. Adjustable taper gibs at the side and top of the turret slide assure the proper fit under all conditions. The hexagon turret revolves on an adjustable tapered roller-bearing center stud and under the slide are hardened replaceable plates.

The motor and drive are completely enclosed in a cabinet leg directly under the head end of the machine which has doors on either side to permit ready access to the motor. Multiple V-belt equipment is furnished.

Tool Opens Flanges For the Renewal of Gaskets

Flange-Jacks are tools designed to open flanges on existing pipe lines for the renewal of gaskets. Using this tool, the flanged joints are opened quickly without damage to the flange faces. There will be no sparks or vibration in the pipe line as might result from hammer blows on chisels or wedges. As the jackscrews are tightened, the flanges are separated gradually and evenly.

To replace gaskets, two bolts are first removed from the flanges. The jaws of a jack are placed in each of these bolt holes and the screws are tightened just enough to hold the jacks in position. The remainder of the bolts are then removed, after which the jackscrews of both jacks are tightened down at the same time so the flanges will separate evenly. When a sufficient opening has been obtained, the old gasket may be removed and a new gasket applied.

Flange-Jacks have jaws of one-piece steel forgings and steel screws, the points of which are case hardened. In laboratory tests this tool has opened joints against a load of 15 tons without damage to the jacks or the flanges. They are always used in pairs and are available in three sizes for opening up to 48-in. standard flanges and 30-in. extra heavy flanges. These tools are a product of the Garlock Packing Company, Palmyra, N. Y.

The flanges are being separated by Flange-Jacks

High Spots in

Railway Affairs . . .

Railroad Safety Records Broken

The Interstate Commerce Commission first began to compile records in 1888. Statistics just released indicate that in the year 1939 fewer passengers suffered fatalities in railroad accidents than in any year since the Commission began making such reports. Thirteen persons lost their lives in train accidents in 1939, nine of these occurring in one accident which the report of the Interstate Commerce Commission ascribed to sabotage. Fourteen passengers were fatally injured in train service accidents in 1939, these accidents consisting for the most part of mishaps in getting on and off moving trains.

Predict Increase in Freight-Car Loadings

The reports of the thirteen Shippers' Advisory Boards indicate that the freight-car loadings in the second quarter of this year will be about 18.1 per cent above those for the same period last year. These estimates cover the 29 principal commodities. The percentages for the different boards vary considerably. The Ohio Valley Board estimates an increase of 74.9 per cent, and is followed by the Allegheny with 57 per cent, the Northwest board with 26.4 per cent, the Pacific Coast board with 14.9 per cent, and the Great Lakes board with 10.1 per cent. From this they taper down, but only one board, the Southwest, estimates a decrease, amounting in that case to 4.4 per cent.

Conferees Still At Work on S. 2009

The conferees on the Omnibus Transportation Bill, S. 2009, suspended their meetings on March 23, because of the absence of Chairman Wheeler on a trip to the west coast. Secrecy has been observed as to the progress which has been made in composing the differences between the Senate and the House bills. It is believed, however, that up to the time this was written, agreement had been reached on practically all matters except the Harrington "labor protection" amendment. Since separate bills on forwarder regulation have recently been introduced in both houses, it seems apparent that this phase of the problem has been dropped from consideration in the omnibus bill. The best guess seems to be that the conference report will hardly be presented to Congress before the latter part of this month.

Railway Purchases Last Year

The railroads, even under unfavorable economic conditions, are heavy buyers—measured in dollar terms—of supplies and equipment. Last year, for instance, their purchases passed the billion dollar mark. According to the Railway Age, Class I roads purchased $770,373,361 of materials, supplies and fuel, exclusive of equipment. For these same items the short lines and switching and terminal companies, not controlled by Class I railroads, spent $34,752,418. Likewise, the Pullman Company for its rail line operations expended $11,133,599. Private car-line companies purchased $9,495,717 of materials for their rail line operations. Orders for new locomotives and cars from the equipment builders amounted to $188,839,000.

Railway Net For First Two Months

According to the Bureau of Railway Economics of the Association of American Railroads, the net railway operating income for Class I railroads in the United States for the first two months of 1940 was $78,373,416; this is at the annual rate of return of 2.78 on their property investment. During the first two months of 1938 the rate of return was 1.83 per cent, while during the first two months of 1930, ten years ago, it was 3.79 per cent on property investment. It is of interest to note that the taxation for these two months in 1940 amounted to $61,215,733, while in 1930, when the net return was much larger, they amounted to only $57,179,390. Twenty-nine Class I roads failed to earn expenses and taxes in the first two months of 1940.

Frank Talk About the Waterways

United States Senator Bailey, a Democrat from North Carolina and chairman of the Senate Commerce Committee, certainly made a frank statement, when in speaking before the National Rivers and Harbors Congress, held at Washington last month, he indicated that a halt must be called in government spending for the improvement and maintenance of the country's rivers and harbors. Moreover, he suggested that those who use the rivers, harbors and canals should pay at least the annual upkeep of $52,000,000. He said that President Roosevelt had warned him that the time had come to cease voting large authorizations for river and harbor improvements and had urged that no bill be enacted at this session.

Fewer Fatalities At Grade Crossings

The ownership of automobiles in this country has steadily increased in recent years, from the low point in the 30's of 23,843,591 on December 31, 1933, to 29,485,680 on December 31, 1938, and naturally is still greater today. In spite of this, grade crossing accidents have been on the decrease. The railways and safety organizations have conducted spirited campaigns and undoubtedly automobile drivers have been stimulated to take greater precautions in approaching and passing over highway grade crossings. Many such crossings, particularly in critical locations, have been eliminated and there has also been an improvement in grade crossing protection. As a result there were 1,398 fatalities resulting from highway-railroad grade crossing accidents in 1939, a decrease of 119 compared with 1938, and 477 compared with 1937. In the year 1928, when such accidents reached a peak, there were 2,568 fatalities.

Pension Estimates All Wrong

The estimating of future pension liabilities is apparently an illusive sort of problem. It is much like estimating expenses for a family vacation. To be on the safe side one should lean toward the generous side in making the budget, and then should double it. In spite of the fact that most all of the early pension systems went "flooey" and that a whole crop of actuaries had to be raised and carefully nurtured, many pension systems are still giving embarrassment to those who hold the bag. According to Murray W. Latimer, chairman of the Railroad Retirement Board, it looks as if when the board completes its first four years at the end of June next year, the tax collections will have fallen from eight to ten million dollars short of the original estimates, and the board will be called upon to pay out in annuities and other benefits, about $165,000,000 more than contemplated. The principal reason? The average age of retirement has dropped from 67½ years, closer to 66, due largely, it is believed, to the reduction in business and railroad employment, as a result of which "the railroads and the men themselves try to get as many of the older men to retire as possible, and we had a real avalanche of retirements."

Among the Clubs and Associations

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS.—Meeting April 16, Hotel DeSoto, St. Louis, Mo. Speaker: A. R. Ayers, general manager, New York, Chicago & St. Louis. Subject: "Transportation in Connection With the Mechanical Department." Dinner at 6:15 p.m., preceding meeting.

CAR FOREMEN'S OFFICERS ASSOCIATION OF CHICAGO.—Meeting LaSalle hotel, Monday evening, May 13. Various problems in connection with the braking of high-speed trains in both freight and passenger service will be considered. L. K. Sillcox, first vice-president, New York Air Brake Company, will address the group on Braking Trains Under Modern Conditions.

PACIFIC RAILWAY CLUB.—Meeting 7:30 p.m., April 12, Hotel Hayward, Los Angeles, Calif. Speaker: Dr. F. C. Lindvall, assistant professor of electric engineering, California Institute of Technology. Topics: (a) Air Circulating Fans in Refrigerator Cars; (b) Lightweight Passenger Cars Embodying "Above Gravity" Suspension and Skin Stressed Body Construction. Lantern slide illustrations.

EASTERN CAR FOREMAN'S ASSOCIATION.—Meeting Friday, April 12, 8 p. m., the Engineering Societies building, 29 West Thirty-Ninth street, New York. Speaker; George W. Wall, electrical foreman, D. L. & W. Topic: Air conditioning.

NEW YORK RAILROAD CLUB.—Meeting at 7:45 p. m., Thursday, April 18, at the Engineering Societies building, 29 West Thirty-Ninth street, New York. Illustrated talks on the latest developments in the art of stopping high-speed trains by C. D. Stewart, chief engineer, Westinghouse Air Brake Company, and M. N. Trainer, president, Brake Shoe and Castings Division, American Brake Shoe & Foundry Company.

NORTHWEST LOCOMOTIVE ASSOCIATION.—The Northwest Locomotive Association has been formed at St. Paul, Minn., as a medium for the exchange of information by all persons interested in locomotives or motive power. Meetings for discussion and talks will be held on the last Monday of each month except during June, July and August. Officers are: President, H. A. O'Neal, inspector of the Bureau of Locomotive Inspection of the Interstate Commerce Commission; first vice-president, C. F. Guggisberg, mechanical engineer of the Minneapolis, St. Paul & Sault Ste. Marie; second vice-president, Godfrey Lamberg, shop superintendent of the Chicago, Milwaukee, St. Paul & Pacific; third vice-president, A. G. Neese, enginehouse foreman of the Chicago, Milwaukee, St. Paul & Pacific; secretary, G. F. Greenleaf, chief clerk to the mechanical engineer of the Northern Pacific, and treasurer F. W. Taylor, general foreman of the Northern Pacific.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—Meeting May 16, 10:00 a.m., Ansley Hotel Roof Garden, Atlanta, Ga. Speaker: F. L. Huggins, general superintendent, railroad engineering division, Air Reduction Sales Co., New York. Topic: Oxyacetylene Machine Cutting in Railroad Shops.

NEW ENGLAND RAILROAD CLUB.—Meeting April 9. Address by C. H. Buford, vice-president in charge of operation and maintenance, Association of American Railroads, Washington, D. C. At the March meeting E. G. Ringberg, superintendent of shops, Boston & Maine, Concord, N. H., was elected president of the club, and D. P. Carey, assistant general mechanical superintendent NY. N.H. & H., was elected vice-president. C. H. Sherburne, treasurer, and W. E. Cade, secretary, were re-elected.

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings, and places of meetings of mechanical associations and railroad clubs:

AIR BRAKE ASSOCIATION.—R. P. Ives, Westinghouse Air Brake Company, 3400 Empire State building, New York.

ALLIED RAILWAY SUPPLY ASSOCIATION. — J. F. Gettrust, P. O. Box 5522, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. —C. E. Davies, 29 West Thirty-ninth street, New York.

RAILROAD DIVISION.—C. L. Combes, Railway Age, 30 Church street, New York City.

MACHINE SHOP PRACTICE DIVISION.—Warner Seely, Warner & Swasey Co., 5701 Carnegie avenue, Cleveland, Ohio.

MATERIALS HANDLING DIVISICN. — F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.

OIL AND GAS POWER DIVISION. — W. J. Hargest, American Machinist, 330 West Forty-second street, New York.

FUELS DIVISION. — A. R. Mumford, Consolidated Edison Co., 4 Irving Place, New York.

ASSOCIATION OF AMERICAN RAILROADS.—Charles H. Buford, vice-president operations and maintenance department, Transportation Building, Washington, D. C.

OPERATING SECTION.—J. C. Caviston, 30 Vesey street, New York.

MECHANICAL DIVISION.—V. R. Hawthorne, 59 East Van Buren street, Chicago. Meeting Stevens Hotel, Chicago, June 27 and 28.

PURCHASES AND STORES DIVISION.—W. J. Farrell, 30 Vesey street, New York.

MOTOR TRANSPORT DIVISION.—George M. Campbell, Transportation Building, Washington, D. C.

CANADIAN RAILWAY CLUB. — C. R. Crook, 4468 Oxford avenue, N. D. G., Montreal, Que. Regular meetings, second Monday of each month, except June, July and August, at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS. — J. J. Sheehan, 1101 Missouri Pacific Bldg., St. Louis, Mo. Regular monthly meetings third Tuesday of each month, except June, July and August, DeSoto Hotel, St. Louis, Mo.

CAR DEPARTMENT OFFICERS' ASSOCIATION.—Frank Kartheiser, chief clerk, Mechanical Dept., C. B. & Q., Chicago. Annual meeting October 22-25, Hotel Sherman, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago.

CAR FOREMEN'S ASSOCIATION OF OMAHA, COUNCIL BLUFFS AND SOUTH OMAHA INTERCHANGE.—H. E. Moran, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month.

CENTRAL RAILWAY CLUB OF BUFFALO.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday of each month, except June, July and August, at Hotel Statler, Buffalo.

EASTERN CAR FOREMEN'S ASSOCIATION. — Roy MacLeod, Room 127, General Office Bldg., N. Y., N. H. & H., New Haven, Conn. Regular meetings, second Friday of January, February, March, April and October at Engineering Societies Bldg., 29 West Thirty-ninth street, New York.

INDIANAPOLIS CAR INSPECTION ASSOCIATION. — R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

INTERNATIONAL RAILWAY FUEL ASSOCIATION. — See Railway Fuel and Traveling Engineers' Association.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—See Locomotive Maintenance Officers' Association.

LOCOMOTIVE MAINTENANCE OFFICERS' ASSOCIATION.—J. E. Goodwin, general foreman, locomotive department Missouri Pacific, North Little Rock, Ark. Meeting Hotel Sherman, Chicago, October 22-25.

MASTER BOILER MAKERS' ASSOCIATION. — A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y. Annual meeting October 22-25, Hotel Sherman, Chicago.

NEW ENGLAND RAILROAD CLUB. — W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, except June, July, August and September.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Thursday in each month, except June, July, August, September and December at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION. — E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Midway Club rooms, 1931 University avenue, St. Paul.

NORTHWEST LOCOMOTIVE ASSOCIATION.—G. F. Greenleaf, chief clerk to mechanical engineer, Northern Pacific, St. Paul, Minn. Meeting last Monday of each month, except June, July and August.

PACIFIC RAILWAY CLUB. — William S. Wollner, P. O. Box 3275, San Francisco, Cal. Monthly meetings alternately in northern and southern California.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

RAILWAY FUEL AND TRAVELING ENGINEERS' ASSOCIATION.—T. Duff Smith, 1255 Old Colony building, Chicago. Annual meeting, October 22-25, Hotel Sherman, Chicago.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION. —J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

TORONTO RAILWAY CLUB.—D. M. George, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August, at Royal York Hotel, Toronto, Ont.

TRAVELING ENGINEERS' ASSOCIATION.—See Railway Fuel and Traveling Engineers' Association.

VALLEY ANTHRACITE CAR FOREMEN'S ASSOCIATION.—P. P. Kohl, executive secretary, 254 Barney street, Wilkes-Barre, Pa. Regular meetings third Monday of each month.

WESTERN RAILWAY CLUB.—W. L. Fox, executive secretary, Room 822, 310 South Michigan avenue, Chicago. Regular meetings, third Monday in each month, except June, July, August and September.

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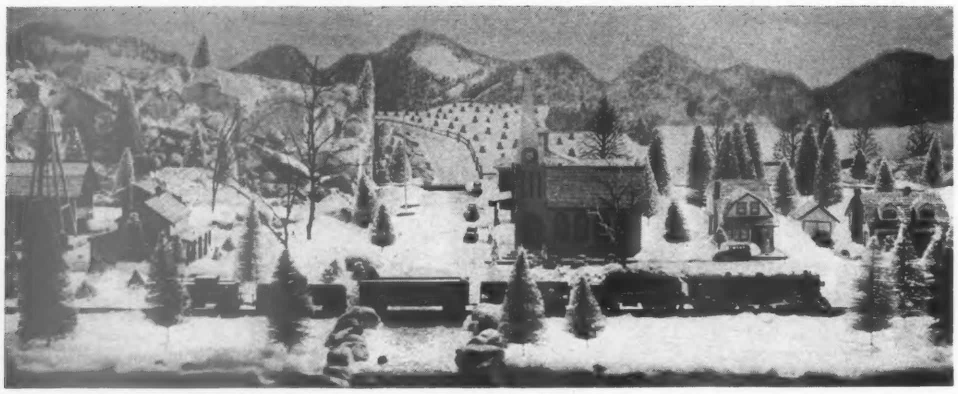

This miniature village with scenic background was built and installed in the home of A. M. Nelson, general foreman, car department, Kingsland shop, Delaware, Lackawanna & Western—The railroad is Lionel standard equipment

NEWS

Air-Conditioned Cars on January 1

CLASS I railroads and the Pullman Company had 11,715 air-conditioned passenger cars in operation on January 1, according to reports received by the Association of American Railroads. This was an increase of 738 compared with the number of air-conditioned passenger cars on January 1, 1939.

Of the total number of such cars, Class I roads on January 1, this year had 6,596, an increase of 574 compared with the same date last year. The Pullman Company on January 1, this year had 5,119 air-conditioned passenger cars in operation which was an increase of 164 compared with January 1, 1939.

Average Speed of Freight Trains in 1939

RAILROADS of the United States in 1939 attained a new high record in the average speed of freight trains, J. J. Pelley, president of the Association of American Railroads announced on February 28. The average speed, according to reports for the year which have just become available, was 62 per cent higher than in 1920.

The average distance traveled per freight train per day in 1939, was 401 miles compared with 398 miles in 1938, and 386 miles in 1937. In 1920, the average was only 247 miles. This represents the average time required for the movement of all freight trains between terminals, including all delays en route.

Federal Locomotive Inspector At Memphis Dies

CLARENCE L. WILSON, who retired as federal inspector of locomotives at Memphis, Tenn., on November 30, 1939, died on February 29. Mr. Wilson, who was born on August 29, 1874, had been federal inspector at Memphis since October 10, 1911. He had previously been in the employ of the Illinois Central, for six years as a boilermaker for seven months as a boiler inspector, and for over six years as foreman boilermaker.

B. & O. Diesel Completes 365th Daily Run Without a Miss

WHEN the Baltimore & Ohio's locomotive No. 56 pulled into Washington, D. C., with the Capitol Limited on February 25, it completed its 365th daily run between Chicago and Washington for a full year without a miss, for a total of more than 280,000 miles. Its performance is claimed to be a new all-time world record of 100 per cent availability for a 12-months' period. The 772-mile run of the Capitol Limited calls for a regularly scheduled average speed of more than 56 m. p. h.—including ten regular stops—over a route which includes some of the heaviest mountain grades in the East.

The train regularly consists of from 11 to 15 Pullman cars of standard weight. In completing the 365 consecutive trips locomotive No. 56 made its arrival in the morning, and departure the same afternoon

(Continued on next left-hand page)

Orders and Inquiries for New Equipment Placed Since the Closing of the March Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Loco.	Builder
Atchison, Topeka & Santa Fe	4	2,000-hp. Diesel-elec.	Electro-Motive Corp.
Chicago, Milwaukee, St. Paul & Pacific	10	4-8-4	Baldwin Loco. Wks.
	12	600-hp. Diesel-elec.	Electro-Motive Corp.
	1	1,000-hp. Diesel-elec.	American Loco. Co.
	2	600-hp. Diesel-elec.	American Loco. Co.
	1	600-hp. Diesel-elec.	Baldwin Loco. Wks.
	1	300-hp. Diesel-elec.	Baldwin Loco. Wks.
	1	360-hp. Diesel-elec.	General Electric Co.
Delaware, Lackawanna & Western..	11	600-hp. Diesel-elec.	Electro-Motive Corp.
	3	600-hp. Diesel-elec.	American Loco. Co.
Lehigh Valley	3	600-hp. Diesel-elec.	Electro-Motive Corp.
	1	600-hp. Diesel-elec.	American Loco. Co.
New York Central	35	Mohawk	American Loco. Co.
	15	Mohawk	Lima Loco. Wks.

LOCOMOTIVE INQUIRIES

Road	No. of Locos.	Type of Loco.	Builder
Iranian State Railways	12-24	2-8-2 or 2-10-2	....
Tennessee Central	1-5	Locomotive tenders	....
United Fruit Co.	4*	2-8-2	....

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
C. B. & Q.	100	70-ton hoppers	Company shops
	25	Gondolas	Company shops
	25	Auto-parts box	Company shops
Illinois Central	62	70-ton hoppers	Gen. American Tran. Co.
New York Central	500	Box	Pullman-Std. Car Mfg. Co.
	500	Box	Pressed Steel Car Co.
	1,500	55-ton hoppers	Despatch Shops, Inc.
Tennessee Copper Co.	8	50-ton air-dump	Pressed Steel Car Co.

FREIGHT-CAR INQUIRIES

Road	No. of Cars	Type of Car	Builder
Chesapeake & Ohio	100	50-ton flat	....
Nashville, Chattanooga & St. Louis..	200	50-ton gondola	....
	50	50-ton hoppers	....
Norfolk Southern	40	Pulpwood	....
	12	Caboose	....
North West Refrigerator Line Co...	100	40-ton refrigerator	....
	100	50-ton refrigerator	....

* For service in South America.


NEW!
.....and it's doing a grand job
The new 2-8-8-4 type steam locomotive illustrated, is one of twelve recently delivered by Lima Locomotive Works to the Southern Pacific for use on high-speed passenger and freight runs in mountainous country. Locomotives such as these are Lima's answer to today's increasing traffic demands.
3803

at each terminal, so that the longest period during the entire year in which it was idle for servicing was 6½ hours. No. 56 is a 3,600-hp. unit built by Electro-Motive Corporation in 1938.

Railroads in North Jersey Reduce Smoke 95 P. C. Since '31

RAILROADS operating in Hudson County, N. J., (the largest terminal area across the Hudson river from New York) have made a reduction in smoke of more than 95 per cent since 1931, according to W. G. Christy, smoke abatement engineer of the county, in his annual report. Comparison is based on 10,396 Ringelmann chart smoke readings which show an average density of locomotive smoke in 1939 of 0.543 per cent, compared with an average density of 16.03 per cent during 1931. The New York, Ontario & Western made the best record of any road with an average of 0.145 per cent density. The West Shore (New York Central) was second on the list with an average of 0.226 per cent.

W. E. Dunham Accepts Editorial Assignment

IN the 1940 edition of the Car Builders' Cyclopedia, compiled and edited for the Association of American Railroads, Mechanical Division, by the Simmons-Boardman Publishing Corporation, which is expected to be ready for distribution early this fall, more space will be devoted to car repair, shop layouts, machine equipment and methods of operation necessary to meet modern requirements. Section 19 of the Cyclopedia on "Car Shops and Car Maintenance," will be rewritten and enlarged, and arrangements have been made to have this done by W. E. Dunham, recently retired superintendent of the car department of the Chicago & North Western and the Chicago, St. Paul, Minneapolis & Omaha. Mr. Dunham, whose career was outlined in the March issue of the *Railway Mechanical Engineer*, will bring to his assignment an intimate and extensive knowledge of all phases of railway car maintenance.

1939 Fuel-Efficiency Record

A NEW high record in fuel efficiency in freight service was established by the railroads of the United States in 1939, J. J. Pelley, president of the Association of American Railroads announced on February 29. For each pound of fuel consumed in freight service, the railroads in 1939 hauled 8.89 tons of freight and equipment a distance of one mile, the highest average on record. In 1938, the average was 8.7 tons, and in 1937, it was 8.6 tons. In 1920, the average was only 5.8 tons.

On the basis of a haul per mile of 1,000 tons of freight and equipment, the railroads in 1939 used an average of 112 lb. of fuel, which amounted to an increase of 35 per cent in fuel efficiency compared with 20 years ago, at which time 172 lb. of fuel were required to perform the same service. In 1938, the average was 115 lb. and in 1937 it was 117 lb. of fuel.

In passenger service the railroads in 1939 used 14.8 lb. of fuel in order to haul a passenger train car one mile, which represented an increase of 21 per cent in fuel efficiency in passenger service, compared with 1920 when the average was 18.8 lb. The average in 1939 was a decrease of one tenth of one pound compared with 1938, and a decrease of three tenths of one pound compared with 1937.

Summer Graduate Institute

A THREE-TERM Summer Graduate Institute for engineers, professional men, industrialists, and educators in engineering and science will be conducted by the Armour Institute of Technology, Chicago, beginning with the summer of 1940. According to Dr. L. E. Grinter, vice-president and dean of the graduate division, who is in charge of the summer institute, each summer scientists of distinction will be invited to lecture on modern developments in engineering and science.

The institute is divided into seven separate and distinct divisions—advanced mechanics, chemical engineering and chemistry, civil and sanitary engineering, electrical engineering and physics, mechanical engineering, industrial engineering, and applied mathematics. The typical graduate course will meet for the equivalent of two hours' lecture daily, including Saturdays, for four weeks. Students will be permitted to carry only one course for credit during each period of four weeks, each such course being credited toward advanced degrees. The terms will be from June 17 to July 13; from July 15 to August 10, and from August 12 to September 7.

In future years the Summer Graduate Institute will be conducted under the direction of the Armour College of Engineering of the Illinois Institute of Technology. This will result from the merger of Armour and Lewis Institutes, which is expected to become effective as of September, 1940, and the subsequent changing of the name of the new combined colleges to the Illinois Institute of Technology.

* * *

Equipment Depreciation Orders

EQUIPMENT depreciation rates for 22 railroads including the Chicago, Milwaukee, St. Paul & Pacific, the Norfolk & Western, the Western Maryland, and the Spokane, Portland & Seattle, have been prescribed by the Interstate Commerce Commission in a new series of sub-orders and modifications of previous sub-orders in No. 15100, Depreciation Charges of Steam Railroad Companies. The composite percentages for all equipment, which are not prescribed rates, range from 2.96 for the Louisville & Wadley to 10.5 for the Colorado, the 15 per cent composite figure for the Angelina & Neches reflecting merely the rate on passenger-train cars, the only equipment covered in the modification of the previous sub-order applying to that road.

The Milwaukee's composite percentage of 4.15 is derived from prescribed rates as follows: Steam locomotives, owned, 4.35 per cent, leased, 3.17 per cent; other locomotives, owned, 3.69 per cent; freight-train cars, owned, 4.12 per cent, leased, 3.54 per cent; passenger-train cars, owned, 3.76 per cent, leased, 4.37 per cent; floating equipment, owned 4.74 per cent; work equipment, owned, 6.54 per cent, leased, 6.87 per cent; miscellaneous equipment, owned, 15.53 per cent, leased, 15.93 per cent.

The composite percentage for the Spokane, Portland & Seattle is 3.32 per cent, derived from prescribed rates as follows: Steam locomotives, new, 2.73 per cent, rebuilt and second-hand, 4.04 per cent; freight-train cars, new 3.17 per cent, rebuilt and second-hand, 7.14 per cent; passenger-train cars, 2.64; work equipment, new, 2.69, rebuilt and second-hand, 4.14; miscellaneous equipment, 13.29.

Prescribed rates for the N. & W. are as follows: Steam locomotives, 3.63 per cent; other locomotives, 3.08 per cent; freight-train cars, 3.55 per cent; passenger-train cars, 3.31 per cent; floating equipment, 3

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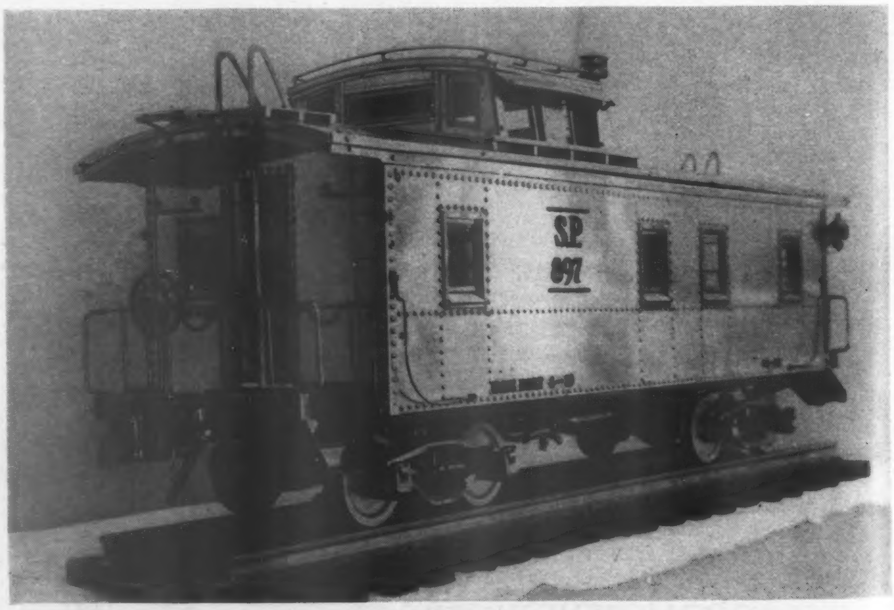

A caboose-car model built by J. M. Fesco of Los Angeles, Calif.
The model, built of aluminum, brass, stainless steel and Dural, weighs 30 lb. — It has working automatic couplers, draft gear, hand brakes, etc., and is complete in detail even to interior appointments—The builder is a locomotive fireman on the Southern Pacific.

per cent; work equipment, 3.07 per cent; miscellaneous equipment, 16.5 per cent. For the Western Maryland the prescribed rates are as follows: Steam locomotives, 3.28 per cent; freight-train cars, 3.58 per cent; passenger-train cars, 2.49 per cent; floating equipment, 2.47 per cent; work equipment, 3.71 per cent; miscellaneous equipment, 9.91.

Canadian National 4-8-4 Type Locomotives

THE first of an order of fifteen 4-8-4 locomotives was delivered to the Canadian National on March 21 by the Montreal Locomotive Works, Ltd. The plans and specifications for these locomotives were prepared under the supervision of John Roberts, chief of motive power and car equipment of the C. N. R. While similar in basic design to locomotives built by the same company for this railroad in 1929, the new locomotives have been modified to permit the installation of equipment not used on the older locomotives. The changes include the installation of auxiliary engines on the trailer trucks, roller bearings on the engine, trailer, and tender trucks, and the application of smoke deflectors.

The locomotives have 73-in. drivers, 25½-in. by 30-in. cylinders, and the boilers carry a pressure of 250 lb. The total weight of the engine and tender in working order is 686,700 lb. The tender loaded with 11,600 gallons of water and 20 tons of coal weighs 284,000 lb. The total weight of the engine—402,700 lb.—is 19,700 lb. more than the total weight of the engines built in 1929. They have a tractive force of 57,000 lb. with an additional 10,000 lb. supplied by the auxiliary engine.

Although the locomotives are primarily intended for use in fast freight service, their characteristics make them adaptable also for use in heavy passenger service.

Equipment Purchasing and Modernization Programs

Chicago, Milwaukee, St. Paul & Pacific.—The 1940 improvement budget of the Milwaukee, which provides for the expenditure of $8,00,000 has been approved by the federal district court.

A total of 2,000 steel box cars and 25 steel, wood-lined cabooses will be built in company shops, and 25 steel coaches will be remodeled and air conditioned.

Orders for the ten steam and 18 Diesel-electric locomotives have been placed as shown in the table of orders for equipment placed since the closing of the March issue.

The $8,000,000 includes only 20 per cent of the cost of the new steam locomotives and box cars, the remainder being covered by equipment trust certificates to be taken by the R. F. C. The Diesel-electric locomotives will be acquired on a lease-purchase plan.

Chicago, Rock Island & Pacific.—The federal district court has authorized the expenditure of $1,528,000 for five more Rockets. The equipment for these trains will include two 1,000 hp. and three 2,000 hp. Diesel-electric locomotives, three cafe lounge, three chair, two coaches and two mail-baggage cars. Of these, six cars and two locomotives will be used in one train each way daily between Memphis, Tenn., and Amarillo, Tex., to replace the present steam train between Little Rock, Ark., and Amarillo, and the present steam and motor car service between Little Rock and Memphis. Two cars and two locomotives are for one train in each direction daily between Kansas City, Mo., and Colorado Springs, Colo., to replace steam-train service. Two cars and one locomotive are for one train daily between St. Louis, Mo., and Minneapolis, Minn., and will replace steam trains operated between Burlington, Iowa, and Manly. It will be operated in conjunction with the Chicago, Burlington & Quincy.

It is asserted that these new trains will produce operating savings of $192,279 and additional revenue of $350,000. To finance the new equipment the court authorized the Rock Island to sell 1,243 refrigerator cars to the General American Transportation Corporation for $1,345,235 and apply part of this money to the purchase of the new equipment. These refrigerator cars were leased to General American in 1932.

Louisville & Nashville.—The L. & N. has been engaged at its South-Louisville, Ky. shops, on a modernization program converting 1,000 wooden-sided, single-sheathed box and automobile cars to all-steel box cars. The work of dismantling the old cars and building the new cars from the underframe up was begun in December, 1939.

P. S. & N. Asks Relief from Automatic Stoker Order

THE Pittsburg, Shawmut & Northern has asked the Interstate Commerce Commission to be relieved from the automatic stoker order so that it may operate its old locomotives without automatic stokers up to April 15, 1944, the date when all heavy locomotives in high-speed service must be so equipped. The company contends, in its petition, that the engines that it now operates are in slow freight service and are not of sufficient value to justify the cost of installation of automatic stokers. The commission's order had decreed that one-fifth of each road's engines falling in the specified class, must be equipped each year so that all would be so equipped by April 15, 1944.

Supply Trade Notes

HARRY N. HAYES, Chicago district sales manager of the Coffing Hoist Company, Danville, Ill., has been promoted to the position of general sales manager.

◆

JOHN F. MCDONNELL has been appointed western manager of the Railroad division of the Home Rubber Company, New York. Mr. McDonnell's office is at 168 North Clinton street, Chicago.

◆

EDGAR C. THOMAS, sales engineer of the Thomas Machine Manufacturing Company, Pittsburgh, Pa., has established an eastern district sales office for the company at 1258-W Commercial Trust building, Philadelphia, Pa.

◆

DAVID T. MARVEL, formerly manager tube sales, Timken Steel and Tube Division of Timken Roller Bearing Co., Canton, Ohio, has entered the service of the National Tube Company as assistant manager of sales, Ellwood Sales Division, Ellwood City, Pa.

TEMPLETON, KENLY & COMPANY.—*J. B. Templeton,* vice-president, Chicago, has been elected president to succeed *W. B. Templeton,* who is now chairman of the board. J. B. Templeton has been associated with the company since 1928. After working in the shops and office, he entered the sales department and later became manager of the New York office. In 1935, when W. B. Templeton, who founded the firm in 1899, traveled to develop the company's business in foreign countries and remote parts of the world, J. B. Templeton assumed the duties of vice-president and sales manager.

J. B. Templeton

◆

LANDIS MACHINE COMPANY.—*C. N. Kirkpatrick* has been elected vice-president and general manager, and *J. H. Elliott,* secretary, of the Landis Machine Company, Waynesboro, Pa. Mr. Kirkpatrick was formerly vice-president in charge of sales and secretary of the company. Mr. Elliott continues also as purchasing agent.

◆

TIMKEN ROLLER BEARING COMPANY.—*William H. Richardson,* general manager

(*Continued on next left-hand page*)

ANYTHING

less than a complete arch

IS FALSE ECONOMY

To let the desire for reduced inventory result in a locomotive leaving any roundhouse without a full set of Arch Brick is poor economy. › › › Even a single missing Arch Brick will soon waste many times its cost in fuel and in locomotive efficiency. › › › To spend the fuel dollar efficiently, every locomotive Arch must be maintained 100%. › › › Be sure your stocks on hand are ample to provide fully for all locomotive requirements, so that locomotive efficiency may be maintained.

There's More to SECURITY ARCHES Than Just Brick

HARBISON-WALKER REFRACTORIES CO.
Refractory Specialists

AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.
Locomotive Combustion Specialists

of the service-sales division of the Timken Roller Bearing Company, Canton, Ohio, has been appointed assistant general sales manager. Mr. Richardson has been succeeded by *E. H. Austin,* assistant general manager of the sales-service division. *R. P. Proffit,* representative at Chicago, has been promoted to Chicago division manager. *Jay Irwin* has been appointed Chicago district manager of the steel and tube division, Canton.

◆

JOHN A. DILLON who has resigned as vice-president in charge of eastern sales at New York of the Pittsburgh Screw & Bolt Corporation, Pittsburgh, Pa., has formed the Standard International Sales Corporation, with an office in the New York Central building, New York. Mr. Dillon is president of the company and Norman Allderdice vice-president and secretary. The company will engage in export and domestic sales of steel and allied products, specializing in sales to railroads, car and locomotive builders, ship-builders and oil companies.

◆

GENERAL ELECTRIC COMPANY.—Three appointments have been made in the Transportation department at Erie, Pa.: *E. W. Brandenstein* has been appointed head of the Railroad Electrification section, *E. E. Kearns,* head of the Urban Equipment section, and *R. D. Krape,* head of the Diesel-electric Locomotive section.

R. D. Krape began work with the General Electric in 1911, following his graduation from Pennsylvania State College. In 1913, he joined the railway equipment engineering department in Schenectady, and

R. D. Krape

since 1926, has been a commercial engineer in the general office of the Transportation department at Erie.

◆

THE AMERICAN BRAKE SHOE & FOUNDRY COMPANY has purchased the Great Lakes Forge Company of Chicago which will be operated as the American Forge Division of the American Brake Shoe & Foundry Company.

◆

LUKENS STEEL COMPANY.—*George L. Gordon,* in charge of the New York office of the Lukens Steel Company, has been transferred to the company's main office at Coatesville, Pa. *J. J. Reynolds,* sales representative in the New York office for the past 13 years, has been appointed manager of sales at New York.

◆

ROBERT G. SONQUIST, who has been associated with the American Steel Foundries for the past 21 years, has resigned and accepted a position in the New York office of the Standard Railway Equipment Company.

◆

THE GARLOCK PACKING COMPANY.—*F. E. Erlandson,* district manager at St. Louis, Mo., of The Garlock Packing Company, Palmyra, N. Y., has been appointed district manager of the company's Cleveland, Ohio, branch succeeding *R. W. Perkins,* resigned. *H. J. Kuhn,* sales representative of the St. Louis, Mo., branch, has been appointed manager of that branch to succeed Mr. Erlandson.

◆

AMERICAN STEEL FOUNDRIES.—A. W. MacLaren, assistant vice-president, with headquarters at New York, has been elected vice-president with the same headquarters, to succeed W. J. Lynch, retired. E. M. Van Winkle succeeds Mr. MacLaren as sales agent at New York.

A. W. MacLaren entered railway service in 1898 in the accounting department of

A. W. MacLaren

the Cleveland, Cincinnati, Chicago & St. Louis, at Cincinnati, and in 1899, was promoted to chief clerk in the passenger department, with the same headquarters. In 1902 he became secretary to the president, and in 1905, when the Big Four became a part of the New York Central System, he was promoted to assistant to the vice-president in charge of traffic of the New York Central, with headquarters at Chicago. In 1907 he was transferred to New York, and in 1910 resigned to become general traffic manager of Morris & Company, Chicago. In 1923, he resigned to become vice-president in charge of sales of the Chicago Bearing Metal Company, Chicago, and in the following year entered the employ of the American Steel Foundries as sales agent at New York. In 1930, he was appointed assistant vice-president.

E. M. Van Winkle graduated from Purdue University in 1921 as a chemical engineer and immediately entered the employ of the American Steel Foundries as a special apprentice. After serving in various capacities, he was employed in the in-

E. M. Van Winkle

dustrial sales department for ten years and in June, 1939, was appointed sales agent at New York.

W. J. Lynch entered the employ of the American Steel Foundries as vice-president in 1911. For a number of years previous he was employed by the New York Central.

◆

W. C. DABNEY, president of the Jones-Dabney Company, Louisville, Ky., has been elected a vice-president of Devoe & Raynolds Company, Inc., with supervision of Devoe's Railroad and Marine Paint divisions. Mr. Dabney will have his headquarters, as formerly, at Louisville.

◆

LUKENWELD, INC.—*Edward J. Charlton* has been appointed general manager of Lukenweld, Inc., Coatesville, Pa.; *Robert L. Bunting,* superintendent; *George L. Snyder,* chief engineer; *D. Bruce Johnston,* manager of development and research; *Robert B. Nivison,* chief of inspection; *Robert C. Sahlin,* assistant manager of sales; *S. Nelson Buell,* assistant chief engineer; *Fred W. Forbes,* assistant superintendent; *W. J. McAlpine,* general foreman, and *George Wheatley,* methods engineer.

◆

GEORGE H. HOUSTON, formerly president of the Baldwin Locomotive Works, has joined with Hendrik R. Jolles to form the firm of Houston & Jolles, industrial and financial consultants, with office at 52 Wall street, New York. Edward W. Higgins, also formerly with the Baldwin Locomotive Works, is associated with Houston & Jolles.

Obituary

DAVID C. JONES, vice-president and general manager of The Lunkenheimer Company, Cincinnati, Ohio, died on March 11, after a brief illness. He was born at Cincinnati on November 14, 1876, and entered the employ of the Lunkenheimer Company in January, 1894. Mr. Jones also had served as president of the American Supply & Machinery Manufacturers' Association.

Personal Mention

General

A. E. Coleman has been appointed superintendent of the St. Clair tunnel, Canadian National, with jurisdiction over all mechanical and electrical operation, succeeding M. J. Nottingham, who has been assigned to other duties.

B. H. Smith, whose appointment as superintendent of motive power of the Second district of the Chicago, Rock Island & Pacific, with headquarters at Kansas City, Mo., was announced in the March issue, entered railway service on September 1, 1894, as a machinist apprentice on the Northern Pacific at Brainerd, Minn. He later served as a machinist on various roads from January, 1900, until May, 1903, when he became enginehouse foreman on the Atchison, Topeka & Santa Fe at Chicago. In May, 1904, he was appointed division foreman at Marceline, Mo., later being transferred to Emporia, Kan. In January, 1907, he became a representative of a railroad supply company and in October, 1908, went to Caldwell, Kan., as general foreman of the Chicago, Rock Island & Pacific. Mr. Smith entered the employ of the Kansas City, Mexico & Orient (now part of the Santa Fe system), in March, 1911, as general foreman at Emporia, Kan., and in October, 1914, returned to the Rock Island as general foreman at Fairbury, Neb. In October, 1918, he was appointed master mechanic, serving successively at various points, including Fairbury, Estherville, Iowa, Horton, Kan., Little Rock, Ark., and Des Moines, Iowa.

John S. Morris, who has been appointed electrical engineer of the New York, Chicago & St. Louis, with headquarters at Cleveland, Ohio, was born on February 11, 1892, at Denison, Tex. He was a graduate in mechanical and electrical engineering from Cornell University in 1917. In June of that year he entered railroad service on the New York, Chicago & St. Louis as a special apprentice. Two years later he became assistant engineer. From 1923 to 1933 Mr. Morris served successively as engineer of shops and machinery, general foreman and mechanical inspector. For the next three years he worked as master mechanic on the Chicago Great Western, rejoining the New York, Chicago & St. Louis in 1936 as mechanical assistant.

Master Mechanics and Road Foremen

E. J. Cyr, master mechanic of the Chicago, Burlington & Quincy at McCook, Neb., has been transferred to Chicago.

C. F. Deno, division master mechanic on the Canadian Pacific at Moose Jaw, Sask., has been transferred to Regina, Sask.

August Thomas, locomotive foreman on the Canadian Pacific at Moose Jaw, Sask., has been appointed division master mechanic, with the same headquarters, succeeding C. F. Deno.

C. S. Hogan has been appointed master mechanic of the McCloud River Railroad, with headquarters at McCloud, Calif., succeeding to a portion of the duties of John Kennedy.

William Schwartz, day enginehouse foreman of the Chicago, Burlington & Quincy, at Casper, Wyo., has been appointed master mechanic at that point.

C. E. Bloom, maser mechanic of the Chicago, Burlington & Quincy at Casper, Wyo., has been transferred to McCook, Neb.

C. E. Farley, master mechanic of the Chicago, Rock Island & Pacific at Silvis, Ill., has been transferred to Des Moines, succeeding Mr. Smith.

D. N. Meyers, special duty engineman on the Ft. Wayne division of the Pennsylvania, has been appointed assistant road foreman of engines of the Logansport division, with headquarters at Logansport, Ind.

H. C. McCullough, master mechanic of the Chicago, Rock Island & Pacific at Cedar Rapids, Iowa, has been transferred to Silvis, Ill.

Charles L. Christy, day enginehouse foreman on the Missouri Pacific at Falls City, Neb., has been promoted to assistant master mechanic at Wichita, Kan., succeeding T. C. Carter.

S. E. Mueller, superintendent of the second district of the Chicago, Rock Island & Pacific at Kansas City, Mo., has been appointed master mechanic at Cedar Rapids, Iowa.

Frank J. Topping who has been appointed master mechanic of the Chesapeake & Ohio at Hinton, W. Va., as announced in the February issue, was born on May 10, 1890, at Roanoke, Va. He attended the

Frank J. Topping

public schools of Virginia and received his technical training through the International Correspondence Schools. He entered the employ of the C. & O. in June, 1907, and until 1911 was a machinist apprentice, working two months of his apprenticeship as a storekeeper and three months as a locomotive fireman. He was a machinist on the Norfolk & Western at Williamson, W. Va., and at Roanoke, Va.; on the Virginian at Princeton, W. Va., and Elmore, and on the C. & O. at Hinton, W. Va., Thurmond and Huntingdon, until June 1916. He then served as enginehouse foreman of the C. & O. at Ronceverte, W. Va., and Clifton Forge, Va., respectively, until January 1, 1919, when he became air brake machinist at the latter point. Upon his promotion to the position of general foreman on September 1, 1919, Mr. Topping served at Ronceverte until June 20, 1923; at Clifton Forge until March 15, 1933, and at Hinton until October 15, 1937. On that date he was appointed assistant master mechanic, with headquarters at Hinton; on October 1, 1938, became assistant master mechanic of the Cincinnati division, and on January 1, 1940, returned to Hinton as master mechanic.

J. W. McCarthy, road foreman of engines of the Erie at Hornell, N. Y., has retired. Mr. McCarthy had been in the service of the Erie for 49 years.

Peter Hessberger, road foreman of engines of the Erie at Port Jervis, N. Y., has retired. Mr. Hessberger had been in the service of the Erie for 49 years.

H. G. Fuller, assistant road foreman of engines of the Logansport division of the Pennsylvania, has been appointed assistant road foreman of engines of the Ft. Wayne division, with headquarters at Ft. Wayne, Ind.

Car Department

D. J. Hayes, car foreman at Chapleau, Ont., of the Canadian Pacific, has been transferred to Outremont, Que., succeeding T. J. Payne, retired.

Edgar Eaton, assistant foreman of the Canadian Pacific at Quebec, Que., has been appointed to the position of car foreman at Chapleau, Ont., succeeding D. J. Hayes.

Shop and Enginehouse

J. M. Webster, superintendent of the Bellmead back shops of the Missouri-Kansas-Texas at Waco, Tex., retired on February 1.

T. C. Carter, assistant master mechanic on the Missouri Pacific at Wichita, Kan., has been appointed day enginehouse foreman at Falls City, Neb.

H. C. Gugler, master mechanic of the Chicago, Burlington & Quincy at Chicago, has been appointed superintendent of shops at Aurora, Ill., succeeding J. W. Cyr, who has retired.

T. H. Evans, general foreman of the Missouri-Kansas-Texas at Waco, Tex., has been promoted to the position of superintendent of the Bellmead back shops at Waco.

A. C. Gunning, machinist on the Canadian National at Blue River, B. C., has been promoted to the position of locomotive foreman at Blue River.

Walter Medlock, day enginehouse foreman of the Denver & Rio Grande Western
(Continued on second left-hand page)

at Grand Junction, Colo., has been promoted to the position of general foreman, with headquarters at Grand Junction.

J. W. DOUGLAS, locomotive foreman on the Canadian Pacific with headquarters at Kenora, Ont., has been promoted to the position of general foreman at Moose Jaw, Sask.

J. NEILL, night chargehand on the Canadian Pacific at Nelson, B. C., has become locomotive foreman at Nelson.

J. MCRAE, locomotive foreman on the Canadian Pacific at Nelson, B. C., has been transferred to Coquitlam, B. C., succeeding F. C. Johnson.

F. C. JOHNSON, locomotive foreman on the Canadian Pacific at Coquitlam, B. C., has become general foreman at Revelstoke, B. C.

J. S. MCNEIL, locomotive foreman on the Canadian National at Blue River, B. C., has been transferred to the position of locomotive foreman at Kamloops Junction, B. C.

GEORGE P. BOWMAN, assistant foreman in the erecting shop of the Norfolk & Western at Roanoke, Va., has been appointed general foreman at Shaffers Crossing shops, Roanoke.

J. A. MARTIN, assistant foreman on the Canadian Pacific at Quebec, Que., has become assistant foreman, with the same headquarters, succeeding Edgar Eaton.

Purchasing and Stores

U. K. HALL, general storekeeper of the Union Pacific, with headquarters at Omaha, Neb., retired on March 31, because of ill health, after 42 years continuous service on the Union Pacific. Mr. Hall was born at Portland, Ore., on September 12, 1878, and entered railway service in 1897 with the Union Pacific System. He advanced through various positions in the purchasing, accounting, operating, engineering and stores departments. He was appointed general storekeeper of the Oregon-Washington Railroad & Navigation Company (now a part of the Union Pacific) at Portland, Ore., in 1913, which position he held until 1916 when he was sent to Omaha as general storekeeper of the Union Pacific. During the World War Mr. Hall was stationed at Washington, D. C., as assistant to the manager of stores of the United States Railroad Administration. Following the war he was appointed general supervisor of stores of the Union Pacific System, which position he held until April, 1932, when his title was changed to general storekeeper of the system. In January, 1933, he became general purchasing agent, with headquarters at Omaha, and in August, 1937, was re-appointed general storekeeper. Mr. Hall served as chairman of the Purchases and Stores division of the American Railway Association in 1923-24 and is at present a member of the advisory committee of the P. and S. Division.

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Moving the 2,000-Hp. Electro-Motive Diesel-electric locomotive into the General Motors 1940 exhibit at the New York World's Fair

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

MATERIAL - HANDLING EQUIPMENT.—Lewis-Shepard Sales Corp., Watertown, Mass. Catalogue No. 21 of floor and hand trucks, skid platforms, cranes, stackers, etc.

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BEARING BRONZE.—Johnson Bronze Company, New Castle, Pa. Catalogue 400. Describes over 800 sizes of plain bearings, with more than 350 listings of bronze bars.

◆

STEEL.—Republic Steel Corporation, Republic building, Cleveland, Ohio. Two-color, 40-page catalogue, Form Adv 353, on Republic Double Strength steel, with seventeen pages showing applications in specific industries.

◆

SPRINGS.—Fort Pitt Spring Company, P. O. Box 1377, Pittsburgh, Pa. 36-page illustrated catalogue, No. 4. Elliptic freight-truck, equalizing, compression, coil, and helical springs, with specifications, calculations, formulas and other useful data.

◆

LATHES.—The R. K. LeBlond Machine Tool Co., Edwards & Madison Road, Hyde Park, Cincinnati, Ohio. Colorful 50-page spiral-bound book, "March of the Masters," shows part lathe has played in development of great men and industry and describes LeBlond line of Regal and Super Regal lathes.

◆

SPRAY-PAINTING EQUIPMENT.—The DeVilbiss Company, Toledo, Ohio. 32-page illustrated booklet, "ABC of Spray Painting Equipment." Contains common questions and answers pertaining to operation and use, care and adjustment of spray-painting equipment. Price, 25 cents.

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METCOLIZING.—Metallizing Engineering Co., Inc., 21-07 Forty-First avenue, Long Island City, N. Y. Bulletin P-11 describes Metcolizing, a process for protection of iron and steel and some other metals against oxidation and scaling at elevated temperatures.

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ARC WELDING ELECTRODES. — Wilson, Welder and Metals Co., Inc., 60 East Forty-Second street, New York. Twenty-four-page booklet descriptive of application, procedure for use, and physical properties of Wilson electrodes for numerous and varied welding purposes. Section devoted to Welding Symbols and Instructions for Their Use.

◆

TURRET LATHE TOOLS.—Gisholt Machine Company, 1289 East Washington avenue, Madison, Wis. 40-page catalogue, Form 1059B, describes entire line of Gisholt standard tools for ram type turret lathes, including several new additions such as multiple cutter turners and slide tools.